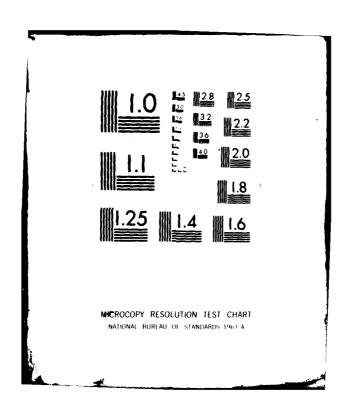
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ADVANCED SUBSYSTEM STATUS MONITOR

ADA 085135

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April 1980

Final Report for Period October 1978 - October 1979

Approved for public release; distribution unlimited.

Prepared for

APPLIED TECHNOLOGY LABORATORY

U. S. ARMY RESEARCH AND TECHNOLOGY LABORATORIES (AVRADCOM)

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APPLIED TECHNOLOGY LABORATORY POSITION STATEMENT

This report addresses a promising approach for reducing pilot workload in Army helicopter cockpits. The approach advocates combining the multitude of presently used subsystem instruments and annunciator displays into two multifunctional flat-panel cockpit indicators. It is believed that this work effort represents a first-time attempt to apply multifunction display technology and human factors engineering techniques to the problems of man-machine communication and pilot workload associated with monitoring the status of helicopter subsystems. The results of this effort are being exploited by the U. S. Army Avionics Research and Development Activity, Fort Monmouth, New Jersey, as part of the Electronic Master Monitor and Advisory Display System (EMMADS) development.

The technical monitor for this effort was Mr. Joseph D. Dickinson, Applied Aeronautics Technical Area, Aeronautical Systems Division, Applied Technology Laboratory.

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18. MONITORING AGENCY NAME & ADDRESS(II 260 5. SECURITY CLASS. (of this report) 261/ UNCLASSIFIED 154. DECLASSIFICATION/DOWNGRADING 16. DISTRIBUTION STATEMENT (of this Report) 315200 APPROVED FOR PUBLIC RELEASE; DISTRIBUTION UNLIMITED. 17. DISTRIBUTION STATEMENT (of the electract entered in Block 20, if different from Report) 18. SUPPLEMENTARY NOTES 19. KEY WORDS (Continue on reverse side if necessary and identify by block number) COCKPIT INTEGRATION **HELICOPTERS** MONITORS ADVANCED COCKPITS DATA DISPLAYS PARAMETRIC ANALYSIS ALPHANUMERIC DISPLAYS INFORMATION PROCESSING SUBSYSTEMS WORKLOAD REDUCTION ANALOG SYSTEMS MISSION PROFILES Five tasks were completed toward the design of an advanced Subsystem Status Monitor that will reduce crew workload during the monitoring of helicopter subsystems: (1) Analysis of parameters currently monitored in the UH-60A, CH-47C, OH-58C, and AH-1G Army helicopters, and recommendation of information requirements for these helicopters, DD 1 JAN 73 1473 EDITION OF 1 NOV 45 IS ORSOLETE

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- (2) Development of prioritization, logic, and display formats for the presentation of subsystem information on multi-function electronic displays for the above-mentioned helicopters,
- (3) Preliminary design of system architectures incorporating state-of the-art, near-term and long-term technologies into an advanced Subsystem Status Monitor,
- (4) Evaluation of preliminary designs to determine predicted impacts on flight safety, workload, reliability and maintainability, survivability and vulnerability, aircraft space and volume, aircraft weight, and life cycle costs,
- (5) Design of keyboard and associated display formats for the following peripheral functions: checklist presentation, performance calculation, and load monitoring.

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INTRODUCTION

All-weather/night/nap-of-the-earth helicopter flight has dramatized the importance of reducing crew workload as a high priority effort toward improving mission effectiveness.

The past and predicted growth in the number and complexity of subsystems in U.S. Army helicopters has made subsystem monitoring a prime candidate for design efforts aimed at the reduction of crew workload.

The effort reported herein was directed toward the reduction of crew workload during the monitoring of subsystems in U.S. Army helicopters involved the application of Human Factors engineering principles and U.S. Army pilot recommendations to the design of an advanced Subsystem Status Monitor (SSM).

Five tasks were completed toward the design of an advanced Subsystem Status Monitor that will reduce crew workload during the monitoring of helicopter subsystems:

- 1. Analysis of parameters currently monitored in the UH-60A, CH-47C, OH-58C, and AH-1G helicopters, and recommendation of information requirements for these helicopters.
- 2. Development of prioritizatization, logic, and display formats for the presentation of subsystem information on multi-function electronic displays for the above-mentioned helicopters.
- 3. Preliminary design of system architecture incorporating state-of-the-art, near-term and long-term technologies into an advanced Subsystem Status Monitor.
- 4. Evaluation of preliminary designs to determine predicted impacts on flight safety, workload, reliability and maintainability, survivability and vulnerability, aircraft space and volume, aircraft weight, and life cycle costs.
- 5. Design of keyboard and associated display formats for the following peripheral functions: checklist presentation, performance calculation, and load monitoring.

TASK I: IDENTIFICATION AND ANALYSIS OF PARAMETERS

Task I included the following efforts:

1. Identification of subsystem parameters currently monitored and displayed in four Army helicopters representative of the following types: utility, cargo, attack, and observation.

2. Cross-comparison of parameters monitored and displayed by each

of the helicopters investigated.

Identification of subsystem monitoring information requirements

for each helicopter investigated.

- 4. Investigation of the desirability of modifying information requirements for changing mission phases, including: pre-/post-start, takeoff, cruise, hover, land, and pre-/post-shutdown; and for changing environmental conditions, including: night/day, visual meteorological conditions/ instrument meteorological conditions, and nap-of-the-earth/ flight at altitude.
- 5. Assessment of current and near-term efforts to improve signal source technology and identification of signal source improvements likely to coincide with development of an advanced Subsystem Status Monitor (SSM).
- 6. Discussion of information requirements with military flight crews rated in relevant helicopter classes during working sessions at Ft. Rucker, Alabama, and incorporation of flight crew inputs into the definition of information requirements.

IDENTIFICATION OF PARAMETERS CURRENTLY MONITORED AND DISPLAYED IN REPRESENTATIVE ARMY HELICOPTERS

Operators Manuals were consulted for the following Army helicopters: UH-60A (utility), CH-47C (cargo), OH-58C (observation), and AH-1G (attack). The following information was tabulated for each helicopter: subsystem parameters displayed, range of each parameter, normal (green zone) operation band for each parameter, precaution (amber zone) limits for each parameter, malfunction (red zone) limits for each parameter, indicator type displaying each parameter, signal source for each parameter, and type of signal source output (parameter type). This data was summarized for each helicopter, and is presented in Tables 1 through 8 in Appendix A.

The UH-60A and the CH-47C are twin engine helicopters, while the OH-58C and the AH-1G are single engine helicopters, and parameter listings in Tables 1 through 8 reflect this distinction. The AH-1G is a tandem helicopter, with separate instrument and caution panels for pilot and gunner. Tables 7 and 8 therefore include an additional column indicating whether the given parameter is displayed to pilot, gunner, or both.

CROSS-COMPARISON OF PARAMETERS

Parameters displayed in the UH-60A, CH-47C, OH-58C, and AH-1G were cross-compared. Tables 9 through 12 in Appendix A summarize these cross-comparisons.



Table 9, which itemizes parameters displayed in all four helicopters, is noteworthy by virtue of its brevity. The parameters itemized in Tables 10 through 12, however, should not be categorized as superfluous, since many of these parameters are representative of subsystems peculiar to specific aircraft.

IDENTIFICATION OF SUBSYSTEM MONITORING INFORMATION REQUIREMENTS

A composite list of all parameters displayed by any of the four helicopters investigated was prepared. The composite list was reviewed for each helicopter independently, and the following requirements were identified:

- 1. Priority of the given parameter information for the given helicopter, classified as follows:
- A. Safety: The information is essential for the maintenance of aircraft and crew safety.
- B. Mission: The information is not safety-essential, but is essential for mission fulfillment.
- C. Maintenance: The information is neither safety- nor missionessential, but is necessary for post-flight maintenance recommendations.
- D. Unnecessary: The information is not safety-, mission-, nor maintenance-essential.
- 2. Mission phases during which it is necessary to display the given information, including takeoff, cruise, hover, landing, and shutdown.
- 3. Mission environments during which it is necessary to display the given information, including: night, day, visual meteorological conditions (VMC), instrument meteorological conditions (IMC), nap-of-the-earth flight (NOE), and flight at altitude.
- 4. Essential but not superfluous display logic, classifying parameters as:
- A. Continual: The information should be displayed continually and automatically.
- B. Critical only: The information should be displayed automatically only when it represents exceedance of critical limits.
- C. Access only: The information should not be automatically displayed under any conditions, but manually accessed display provisions should exist.
- 5. Essential but not superfluous display format, classifying display requirements as:
 - A. Quantitative: Digital readout is essential and sufficient.
 - B. Qualitative: Analog representation is essential and sufficient.
- C. Combined: Combined digital readout and analog representation is required.
- D. Caution: Caution message without digital readout or analog representation is essential and sufficient.
- E. Advisory: Advisory message without digital readout or analog representation is essential and sufficient.

The results of this information requirements analysis are presented in Tables 13 through 16 in Appendix A.

Tables 13 through 16 represent the finalized information requirements resulting from baseline information requirements defined by Sikorsky Human Factors engineers; information requirements analysis by U.S. Army helicopter pilots at Ft. Rucker, Alabama, and flight test pilots at Sikorsky Aircraft; and analysis of the feasibility of incorporating mission phase-specific and environmental condition-specific display logic into the eventual SSM design. The baseline information requirements suggested by human factors engineers are presented in Tables 17 through 20 in Appendix A. Tables 17 through 20 anticipate the format of an information requirements questionnaire that was later submitted to Army pilots at Ft. Rucker and to test pilots at Sikorsky Aircraft, and represent the first step toward the finalized identification of information requirements presented in Tables 13 through 16. The other phases toward finalizing information requirements are described below.

DISCUSSION OF INFORMATION REQUIREMENTS AND DISPLAY LOGIC WITH U.S. ARMY HELICOPTER PILOTS AND SIKORSKY AIRCRAFT TEST PILOTS

A questionnaire soliciting responses to questions concerning information requirements and display-by-exception logic and formats was prepared and presented to 45 Army pilots rated in the CH-47C, OH-58C, and UH-1H helicopters at Ft. Rucker, Alabama. The same questionnaire was presented to Sikorsky Aircraft test pilots with UH-60A experience.

Questionnaire administration was preceded by briefings explaining SSM design goals, display-by-exception philosophy, and instructions, and was succeeded by in-depth follow-up interviews during a one-week visit by human factors engineers and Army contract monitoring and electronics specialists, as well as Army human factors specialists.

A complete sample questionnaire is presented in Appendix B.

The questionnaires were analyzed to form a composite response set for each aircraft. These composite results are presented in Tables 21 through 24 in Appendix B.

INVESTIGATION OF THE DESIRABILITY OF MODIFYING INFORMATION REQUIREMENTS FOR CHANGING MISSION PHASES AND ENVIRONMENTAL CONDITIONS

The subsystem monitoring information currently displayed in the UH-60A, CH-47C, OH-58C, and AH-1G was compiled into a single list of parameters monitored and displayed, by any of the four helicopters. For each parameter displayed, the mission phases during which the parameter is currently relevant were identified for each helicopter. In addition, for each helicopter displaying a given parameter, the type of indicator currently used to display the parameter was identified.

Table 25 in Appendix A presents a Parameter X Helicopter X Mission Phase cross-comparison for each parameter currently displayed. In addition, parameters listed in Table 25 are grouped by subsystem.

Table 25 complements Tables 1 through 8, which list parameters currently displayed in the four helicopters, and Tables 9 through 12, which cross-compare helicopters, by: allowing direct comparison for each parameter of helicopters displaying or not displaying the given parameter, allowing direct comparison for each parameter of the types of indicator currently used to display the given parameter, and grouping all parameters

into subsystems.

Taken together, Tables 1 through 16 and Table 25 suggest that: there is currently a lack of standardization across helicopters of the parameters that are monitored and displayed, even where no helicopter-peculiar requirements exist (engine fire, engine oil quantity, XMSN oil temperature, hydraulic pressure, and electrical power are examples); and while there is general agreement across helicopter types in terms of the indicator type employed in displaying commonly displayed parameters, there are noticeable differences, including vertical scale versus dial instruments, warning versus caution lights, and audio tone auxiliary warnings.

Table 25 does not present recommended information requirements, but rather analyzes the mission-phase relevance of currently displayed parameters. The analytical results presented indicate that with the exception of the APU subsystem, mission-phase distinctions between information requirements are minimal. Where the APU is activated for in-flight use, mission-phase distinctions are further minimized.

In addition to the factor of minimal distinctions between mission-phase information requirements, the following factors argue against designing a separate monitoring/display logic for different mission phases: there is no easily sensed parameter that can be relied upon to govern automatic mode switching by mission phase; and manual mode switching during transitions between mission phases would increase crew workload (manipulation, planning, memory, and decision-making), particularly during single-pilot operation.

Organization of information requirements differentially for differing environmental conditions was also deemed of limited value because: environmental conditions are subject to sudden and frequent fluctuations which cannot be sensed automatically; the requirement to respond to frequently fluctuating environmental conditions by manual mode selection would increase crew workload, especially during single-pilot operation; and information requirements do not differ significantly for differing environmental conditions.

The goal governing the design of the advanced SSM was to reduce crew workload during the monitoring of helicopter subsystems. Throughout the design process, the flexibility of computerized monitors and electronic display devices was therefore consciously bounded by the requirement that the SSM not increase the crew workload by requiring additional manipulation, taxing human memory and information-processing capacity, or delaying response time by complicating decision-making processes. In the cases of mission phase-specific and environmental condition-specific information requirements, an exercise of technological flexibility would negatively impact crew workload, due to the minimal distinctions present.

The major factor governing the stringent requirement for reduced workload is the all-weather/night/NOE flight profile. Rather than attempt to account for this profile as a distinct helicopter mission with peculiar requirements, the all-weather/night/NOE profile was taken as a worst-case workload problem whose solution would transfer automatically to reduced workload under all other situations.

Where only dedicated indicators are permitted, crew workload reduction efforts are limited to the design and placement of individual

indicators and the identification of information requirements that suggest the addition or removal of indicators. Where multi-function displays are permitted, however, the effort to reduce crew wrokload is not limited to identification of information requirements, but rather emphasizes the importance of defining the logic governing the nondedicated display of subsystem information. On this account, Task II (Definition of Information Handling Formats) is viewed as the major effort toward crew workload reduction, and Task I is viewed as a preliminary phase during which human factors engineers and Army pilots defined the information to be displayed and established mutually agreeable principles governing display-by-exception logic for helicopter subsystems.

The information presented in Tables 1 through 25, therefore, must be viewed as merely preliminary to Task II Army pilot reviews and definition by both human factors engineers and Army pilots of display logic and formats.

ASSESSMENT OF SIGNAL SOURCE TECHNOLOGY

Table 26 lists the major types of signal source devices employed in the four helicopters studied for which avenues of improvement have been identified. Figures included are approximate. The majority of improvement avenues listed consist of improved accuracy and reliability without resort to radical design changes. Additionally, however, the following points resulted from assessment of signal source technology:

- 1. Currently, the major avenue of radical signal source design change appears to be fiber-optics technology, which is being employed experimentally in tachometers and heat sensors.
- 2. The only signal source reliability/accuracy/repeatability problems consistently identified by interviewed Army pilots were chip detectors, engine fire detectors, and low fuel detectors.
- 3. An advanced SSM which includes provisions for sensor failure analysis (through computerized modelling and/or cross-comparison of triply redundant sensors) can effectively inhibit the display of false warnings independently of improved signal source technology per se. The preliminary designs identified in Task III contribute toward this end.

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TASK II: DEFINITION OF INFORMATION HANDLING FORMATS

Task II involved the definition of information handling logic and display formats for the presentation of the information recommended in Task I.

DEFINITION OF DISPLAY LOGIC

Tables 27 through 30 in Appendix A summarize the display logic defined for each of the four helicopters studied. The following sections explain the efforts expended to compose Tables 27 through 30.

Identification Of Level Of Urgency For Each Parameter

A questionnaire was presented to helicopter instructor pilots at Ft. Rucker, Alabama, and to test pilots at Sikorsky Aircraft. Pilots were asked to classify parameters as safety critical, mission essential, or maintenance required. Pilot classifications were summed for each parameter, and consensus was identified for each parameter. In addition, Technical Manuals were consulted for each helicopter, and where parameters were classified according to the above categories, classifications were itemized. Where pilot consensus was high, this consensus defined parameter categorization. Where pilot consensus was ambiguous, Technical Manual categorizations were applied.

Results of urgency categorization appear in the column labeled URGENCY in Tables 27 through 30. The primary use of this data was to establish a first-level classification of parameters toward later definition of prioritization for all parameters, and for determining warning/caution/advisory classifications of parameter messages.

Determination of Desirability of Automatic Responses

This effort involved recommendation of automated response to parameter conditions for those cases in which response is not currently automated. The results are tabulated in the column labeled AUTO RESPONSE in Tables 27 through 30. Both Ft. Rucker and Sikorsky pilots questioned generally adhered to the philosophy that automated response to the parameters listed is not desirable. Exceptions include: automatic fuel balancing to maintain within-limits center of gravity; automatic APU actuation after hydraulic system failure, provided that APU in-flight usage is permissible; automatic XFEED or boost pump actuation in response to low fuel pressure, provided that system leakage can be sensed and diagnosed to prevent further loss of fuel that might result from crossfeeding or pumping fuel through portions of fuel systems containing leaks.

Where automatic responses were recommended, it was further decided whether the crew should or need not be informed of automatic corrective action taken. In the past, where automated corrective response action has been incorporated into an aircraft, the question of whether the crew should be informed of the automated response has been debated on an individual case basis, often with consideration in mind for the instrument panel space required for the conveyance of such information via

a dedicated caution light. In addition, the following general principles should and usually do guide decision-making regarding the appropriateness of such feedback:

1. Where the information in question is necessary for the maintenance of safety of flight, for mission go/no-go decisions, or for recommendation of post-flight maintenance, the information should be displayed.

2. Where the information in question represents a change in status of a system whose previous status was known by the crew, the change of status information should be displayed (e.g., automatic change from direct to XFER fuel feed).

The advanced SSM will include two features which also bear upon the decision to display or refrain from displaying feedback of automated responses:

1. On the overwhelming recommendation of Army pilots interviewed, the SSM will include display of precautionary information which assists the crew in predicting caution or warning conditions. The display of loss of redundancy, which has in the past been debated on an individual parameter basis, would be generally recommended for the SSM as a precautionary advisory.

2. While panel space has been an item of concern in the past, the SSM includes multi-function display screens that allow for a more liberal approach to display of advisory and precautionary information.

The items identified as desirable for automatic response feedback are listed in Tables 27 through 30 under the column headed AUTO FEEDBACK.

Specification Of Display/Refrain-from-display Logic

For each parameter, the appropriateness of the following alternatives was determined: display continually; display by exception, without allowing manual access; or display by exception, allowing manual access.

Strictly speaking, Rotor Speed and Power Available were the only parameters recommended for continuous display. Power Available was to be displayed by one instrument combining the status of torque, NG, and TGT. A power cursor on the instrument (see Figure 5) will move to the right if any one of these three basic parameter values increases. When any basic parameter reaches its operating limit, the power cursor will reach the fixed limit line, illuminating an advisory message on the alphanumeric panel.

It was determined through pilot interviews and human factors evaluations that all other parameters should be displayed by exception. That is, dedicated (continual) display of all other subsystem parameters should be replaced by a system logic that automatically displays only parameters that are approaching or have exceeded limits, or that are functionally related to parameters that are approaching or have exceeded limits.

This display-by-exception logic is recommended as a means of presenting essential but not superfluous subsystem data. Its value in terms of workload reduction is viewed as most apparent during high (e.g., NOE) workload environments. It was nonetheless deemed desirable to allow manual access of any parameter, so long as manual access was not relied upon as the sole or primary method of displaying essential subsystem information. This manual access capability complements the automatic

display by exception, enabling a reduction of monitoring workload when flight workload is high, while permitting manual access of additional information when flight workload is low.

The column headed DISPLAY LOGIC in Tables 27 through 30 identifies those messages to be displayed automatically by exception and those items of information which may be manually accessed. Items displayed by exception are subdivided and identified as warning, caution, or precaution conditions/messages. Manually accessible items of information are also identified. It will be noticed that more than one display logic code may be applicable to a single parameter.

In addition, the column headed SYSTEM identifies the system whose related parameters are also displayed in conjunction with the given parameter when the parameter is displayed either automatically or by manual access. Where no system is identified, the parameter is displayed alone when displayed automatically, and is not manually accessible.

Tables 31 through 34 in Appendix A list for each helicopter the parameters that are automatically displayed when any other parameter within the same system is automatically displayed, or that are accessed together when a selected system is manually accessed.

It may be noted in Tables 27 to 30 that while any of the systems may be manually accessed, there is no occasion where the hydraulic or electrical systems will be automatically displayed.

Specification Of Sufficient But Nonsuperfluous Dimensions To Be Displayed

In Tables 27 through 30 the column headed DIMENSION lists the dimensions recommended as sufficient but not superfluous for each display logic alternative of each parameter (Warning, Caution, Precaution, Advisory, Manual Access).

In arriving at recommended dimensions, pilots at Ft. Rucker and Sikorsky Aircraft were asked to identify which parameters required only quantitative display, which required only qualitative display (analog), which required only status display (Warning, Caution, Precaution), and which required combined qualitative and quantitative display. The responses were analyzed for consensus and reviewed by human factors engineers.

It was further determined during interviews with pilots that while engine and transmission parameters require both qualitative and quantitative display, quantitative and/or status displays are sufficient for fuel, hydraulic, electrical, and APU displays. Specific display formats were determined later.

Suggestion Of Parameter Prioritization For Displays

The multi-function display of information dictated that each item of information that could be displayed be assigned a priority that would govern decisions in cases of simultaneous faults. Three steps were undertaken toward assigning priorities:

- 1. Parameters were classified into the following levels of urgency: Safety, Mission, and Maintenance.
- 2. Within each urgency classification, priorities were assigned by classifying each message as Warning, Caution, Precaution, or Advisory.

3. Each parameter was ranked for priority independently of the above classifications and this ranking was applied to the above two levels of prioritization to assign a priority for each item of information to be automatically displayed.

The resulting priority assignments are identified in the column labeled PRIORITIES in Tables 27 through 30. Tables 35 through 38 in Appendix A present prioritized listings of items of information for each helicopter.

Manually accessed information has not been entered into the prioritization, and is coded by an asterisk (*) in the PRIORITIES column of Tables 27 through 30. Manually accessed information will be assigned highest priority on the SSM display.

Suggestion Of Candidate System Events For Automatic Recording

It is recommended that the SSM possess the capability of recording the following information automatically during warning, caution, and precaution conditions for all parameters: time and date for each out-of-tolerance condition; duration of each out-of-tolerance condition; status or quantitative reading, where measureable, for all related (same system) parameters; cumulative frequency of out-of-tolerance conditions since most recent playback. Recommended candidates for automatic recording are listed in Tables 27 through 30 in the column headed AUTO RECORDING.

SUGGESTION OF HUMAN SENSORY CHANNELS TO WHICH SSM INFORMATION SHOULD BE ADDRESSED

The proposed design of the SSM addresses warning, caution, precaution, and advisory messages and relevant data through the visual sensory channel. Auxiliary presentation of SSM information through the auditory channel was deemed worthy of inclusion in long-term designs, subject to experimental research and testing, since the following factors support use of voice warning as a mode of alerting and data transmission:

- 1. The visual channel is heavily loaded during NOE flight.
- 2. Voice warning may prove more attention-getting than visual warning.
- 3. Pilots interviewed have favored reconsideration of voice warning.

Voice warning systems have been developed and tested in the past. Unfavorable results have been due mostly to the following factors:

- 1. Voice warning systems that involve the use of taped messages have suffered from reliability problems (e.g., tape breakage or stretching) and access time lag, including within-message lag between words or phrases.
 - 2. Provisions for intensity dimming have often not been included.
- 3. Voice warning has been provided only as a backup system, in some cases as a third or fourth warning backup. As such, it has not generally been tested thoroughly on its own merits, and has frequently been deemed by pilots to be a nuisance, especially where no override capability has been provided.

Current technology has advanced beyond previous tape systems to include production of synthesized voice through a variety of digitized storage strategies. The following questions require experimental testing

before synthesized voice warning can be recommended as a primary system:

- 1. What are the most effective frequency ranges and speech characteristics (male vs. female, "robot" vs. human, tone of voice, rapidity of speech, etc.) that combine speech intelligibility with distinguishing characteristics that differentiate the voice warning messages from other voice communications?
- 2. Is human reliability superior under voice warning conditions or under visual warning conditions?
- 3. Are voice warning data transmission rates fast enough to permit effective response?
- 4. Can and should voice warning be relied upon to present information beyond alerting and announcing, to include data presentation, emergency procedures presentation, commands, etc.?
- 5. How is voice warning most effectively integrated with other communications in terms of prioritization, crew interaction, etc.?
- 6. Can and should voice warning be extended to other functions beside subsystem status monitoring?
- 7. What design features can maximize the effectiveness of voice warning (e.g., cueing or alerting tone prior to voice message, optimal coding of messages)?

It is recommended that laboratory and flight evaluation of current and future voice warning systems be undertaken. Such evaluations should both evaluate specific technologies and establish generic principles to guide the development of voice warning systems. Evaluative study of voice warning configurations and combined voice/visual configurations should include experimental measurement of performance variables such as error rate, reaction time, and other measures of human religibility and workload.

SUGGESTION OF DISPLAY LOCATIONS

Existing subsystem status monitoring is characterized by three separate display locations:

- 1. A master warning/caution display which consists of warning lights which illuminate to alert that a warning condition is in effect and inform the nature of the condition, and a master caution light which alerts that a caution condition is in effect, without identifying the condition.
- 2. A caution/advisory panel which serves to identify the parameters that are out of tolerance for caution conditions, without qualitative or quantitative indication of parameter level.
- 3. Subsystem instruments which provide qualitative and/or quantitative data for specified parameters.

The proposed SSM will include all three of the above functions, but will combine them into two separate displays, which should be located in such a fashion as to optimize crew alerting and permit transmission of visual information with minimal eye or head movement on the part of the crew member who must otherwise attend to the outside world. The two displays consist of a main display screen and a separate caution/warning/precaution (CWP) display. The CWP display will serve the purpose of alerting and identifying warning, caution, and precaution conditions, and



will, for selected parameters, identify the quantitative condition of those parameters. The ideal location for the CWP display is currently approximated by the master warning/master caution lights, and it is recommended that this CWP display be inset into the leading edge of the glare shield directly in front of the pilot and the copilot, a separate display being provided for each.

Additional SSM information (including relevant system data, a record of current out-of-tolerance conditions, all manually accessed information, and display of any peripherally accessed information) should be presented separately on the main screen display, in a location where relevant system data is readily viewable with a minimal amount of eye or head movement within the constraints of available instrument panel space, and within reach of pilot and copilot for operation of controls. It is recommended that a separate main screen display be provided for pilot and for copilot, and that these screens be located in the instrument panel as close to the crew members as possible in the areas left vacant by the removal of the dedicated subsystem instruments replaced by the SSM.

In the OH-58C only one of each display is necessary and should be located equidistant from pilot and copilot. In the AH-1G, a tandem helicopter, separate displays should be provided for gunner and pilot.

Figures 1 through 4 illustrate anticipated changes achieved by installation of the proposed SSM displays for the UH-60A and the OH-58C.

SUGGESTION OF DISPLAY FORMATS AND SYMBOLOGY

The development of display formats and symbology was guided by the recommendations in Tables 27 through 30 which specify quantitative vs. qualitative vs. combined display formats. In addition, review of literature on symbology and formats resulted in the following guidelines:

- 1. Tendencies to abuse the flexibility of electronic display devices by displaying excess information in high density should be avoided in favor of emphasis upon the display of essential but nonsuperfluous information.
- 2. Quantitative information should be displayed digitally with appropriate scaling incorporated where necessary to prevent digit flicker.
- 3. Qualitative information should include provisions for indication of movement within zones and for indication of critical limits.
- 4. Where qualitative and quantitative information is presented together for a given parameter, scale markings may be eliminated and qualitative and quantitative indications kept distinct.
- 5. Where several system-related parameters are displayed simultaneously, out-of-tolerance parameters should be highlighted.
- 6. Where analog information for several system-related parameters is displayed, the analog scales should be calibrated to allow for quick-scan comparison of parameters.
- 7. All formats should be submitted to experimental evaluation before a final hardware/software decision is made.

Suggestion Of Mode For Control Reaction Feedback

The SSM should duplicate the logic of existing subsystem status

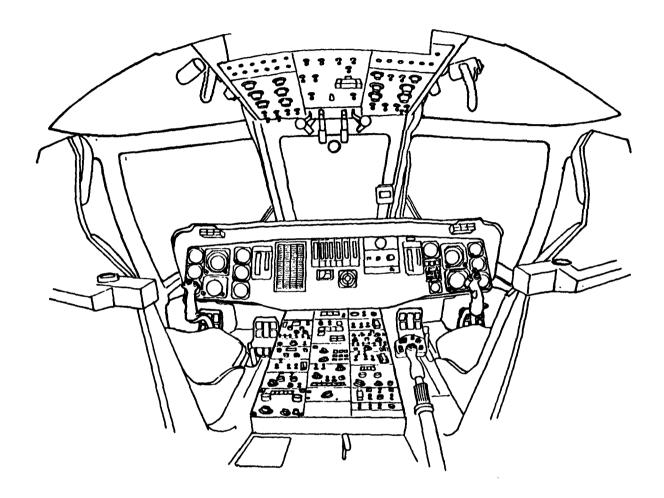


Figure 1. Schematic illustration of the <urrent UH-60A cockpit.

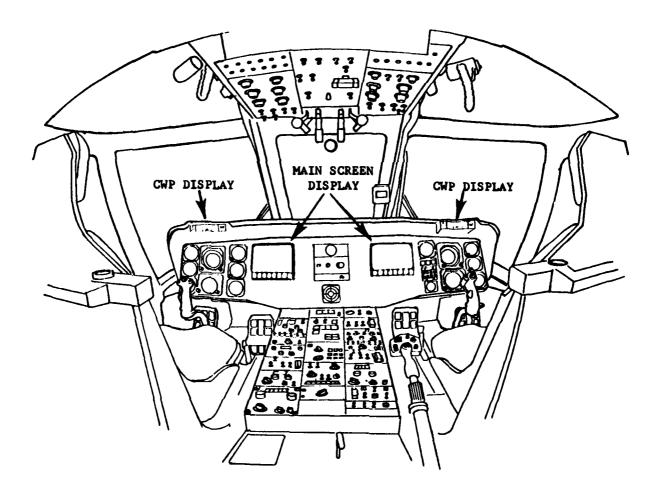


Figure 2. Illustration of SSM installation in the UH-60A.

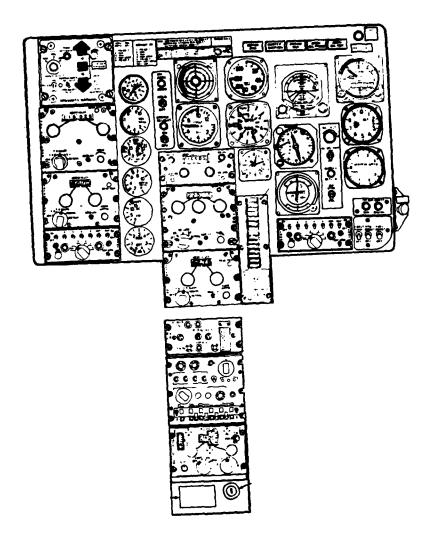


Figure 3. Schematic illustration of the current OH-58C cockpit.

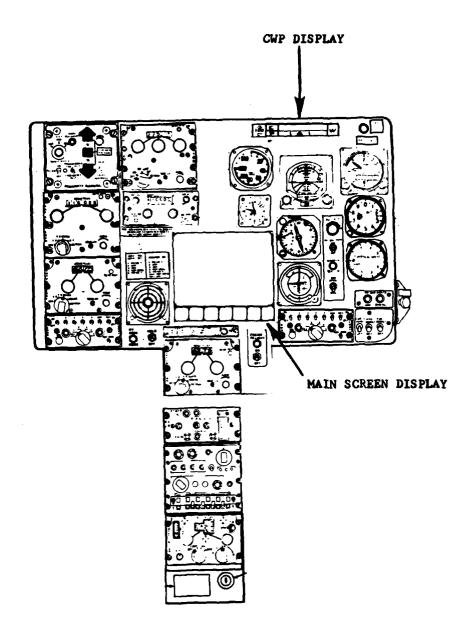


Figure 4. Illustration of SSM installation in the OH-58C.

indicators: corrective response results in the erasure of the caution indication. This logic possesses inherent advantage in that it elevates the SSM to the status of command display. That is, the simplest logic within the environment of high workload NOE flight is a command logic that specifies that the crew need respond only if information appears. An empty screen constitutes feedback that appropriate control reactions have been made. The removal of indications by corrective action reduces the command statements without requiring the crew to monitor excess feedback. Should workload permit, additional feedback, though not required, is attainable through manual access.

Design Of Candidate Display Formats

Figures 5 through 18 illustrate the basic display formats. Figures 19 through 32 illustrate display formats through presentation of an hypothesized scenario. Parameters displayed throughout have been taken from the UH-60A, and the emphasis throughout has been upon illustration of display operation and formats rather than upon fidelity of mission scenario.

Figure 5 illustrates the basic display elements. To the traditional master caution and master warning light has been added a master precaution light. While the master caution and master warning lights are triggered by exceedance of preestablished limits, the precaution light is triggered, by a combination of exceedance of preestablished precaution limits and a rate of approach to caution limits. Thus, the precaution anticipates caution or warning conditions. All three lights are "press to reset" operated. The warning light flashes red, and the caution and precaution lights flash amber. The small screen located between the caution and warning lights is labeled a Caution/Warning/Precaution (CWP) Display. The CWP is a multi-function display and is ideally collimated for compatibility with night vision goggles, requiring no refocusing of the goggles from out-of-cockpit focus for viewing. Whenever a precaution, caution, or warning condition occurs, the appropriate light illuminates and the appropriate message appears on the CWP display. All such messages are prioritized. In the event of simultaneous out-of-tolerance conditions, the highest priority message is displayed until acknowledged by pressing to reset. Until "bumped" by a new message, the highest priority message will remain on the CWP display. For every parameter listed in Tables 27 through 30 as involving precaution display, the CWP display will include digital indication of parameter status in addition to any precaution or caution message displayed. The horizontal display beneath the CWP display is a Power Management Display (PMD). Its arrowhead cursor moves horizontally, driven by the one of the following parameters which is closest to its limit at any given time: torque, NG, and TGT. The vertical line on the PMD represents the caution limit for the above parameters. Ideally this PMD is also collimated for compatibility with the night vision goggles. To the left of the CWP and PMD is a dedicated Rotor Speed (NR) display, which includes dedicated digital readout of NR and directional arrows that illuminate when a specified rate of increase or decrease in main rotor speed is exceeded, and which indicate direction of change. The arrows are not command displays.

The larger display screen with associated control buttons in Figure 5 is the main SSM display. It is a multi-function display allowing for both automatic and manually accessed display of subsystem information. Whenever a precaution, caution, or warning message appears on the CWP display, the message is also automatically displayed on the main screen, where it remains until the condition is corrected. In the case of fuel, engine, XMSN, and APU parameters, a precaution, caution, or warning message for any individual parameter automatically calls up all related system parameters on the main screen. Advisory messages are displayed automatically on the main display, where they remain until the condition is changed. Related fuel, engine, XMSN, hydraulic, electrical, and APU parameters can be accessed manually by pushing the appropriate dedicated button beneath the main display. All parameters are displayed on the main SSM in prioritized fashion; highest priority parameters appear higher vertically on the screen. System-related parameters are displayed together for fuel, engine, and XMSN systems in the vertical location assigned to the parameter within the system that has been assigned highest priority. Any information manually accessed is granted highest priority and may be erased by a second depression of the access button. Relative positions of parameters displayed as part of a related system (i.e., fuel, engine, XMSN) never change, though the prioritized location of the system itself will change as a function of its highest priority parameter.

Where two displays are provided (one each for pilot and copilot in the UH-60A, CH-47C, and AH-1G), all displays except the precaution, caution, and warning lights function independently. Reset of precaution, caution, and warning lights by one crew member results in automatic reset of the corresponding light for the other crew member. Manual access of subsystem information on the main screen, in contrast, functions independently for pilot and copilot.

Review Of Display Logic And Formats With U.S. Army Pilots

The display logic, operation, and formats illustrated in Figures 1 through 32 were reviewed by the same U.S. Army helicopter pilots at Ft. Rucker, Alabama, who had previously provided inputs to the finalized definition of information requirements in Task I. These pilots were generally enthusiastically supportive of the display-by-exception logic and manual access feature. The CWP display was deemed the feature most likely to contribute to reduced workload during NOE flight. Potential contributions of the SSM to increased visibility through reduced instrument panel size were mentioned, and Army personnel recommended that advantage be taken, especially in scout aircraft, of the SSM's replacement of dedicated subsystem instrumentation to improve the overall instrument panel configuration. Decisions to display the highest priority message on the CWP screen, to highlight out-of-tolerance parameters on the SSM main screen, and to emphasize the command philosophy of the SSM (displayed information commands attention and response; blank screens indicate no action to be taken) were firmed through Army pilot interviews. In addition, during one-week followup interviews, peripheral functions that could be performed by the SSM were discussed. These peripheral functions are described in Task V.

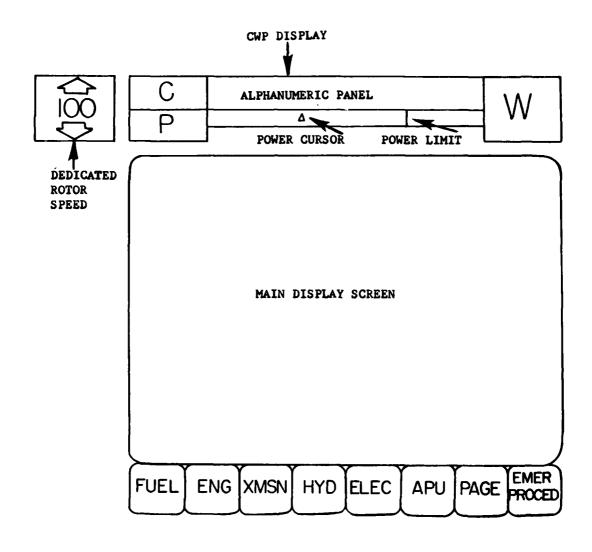
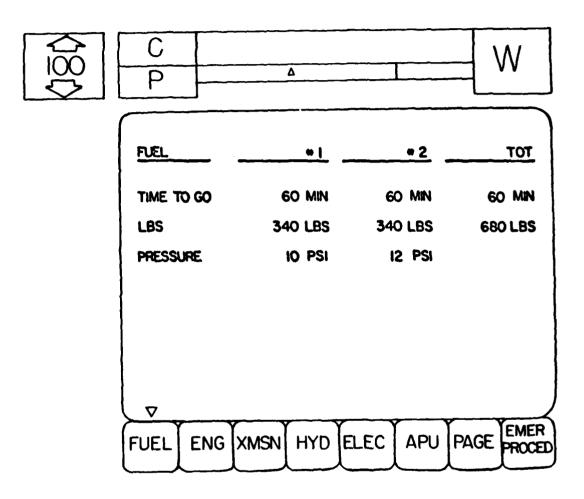


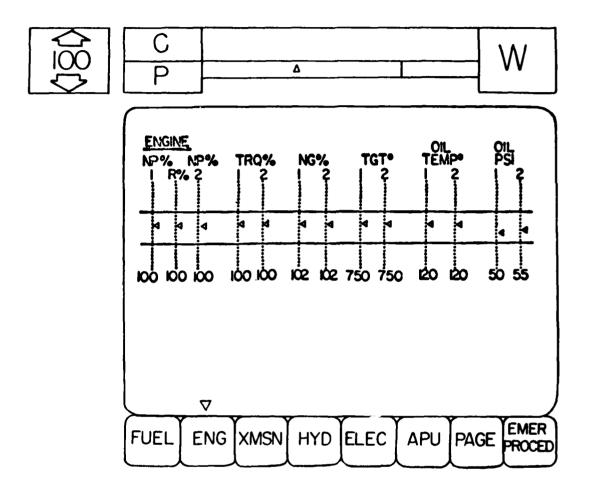
Figure 5. Subsystem Status Monitor display elements.



The FUEL display has been manually accessed. Manual access is indicated by the cursor above the FUEL button. For FUEL, ENGINE, XMSN, and APU, manually accessed display format is identical to the automatically displayed format.

Figure 6. Fuel system display.

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The ENGINE system has been manually accessed. Scale markings have been eliminated, leaving only a dotted vertical line with vertically moving cursors for analog scales. All analog scales for related parameters are calibrated. Horizontal lines indicate upper and lower caution limits. Quantitative digital readouts are displayed beneath each analog scale.

Figure 7. Engine system display.

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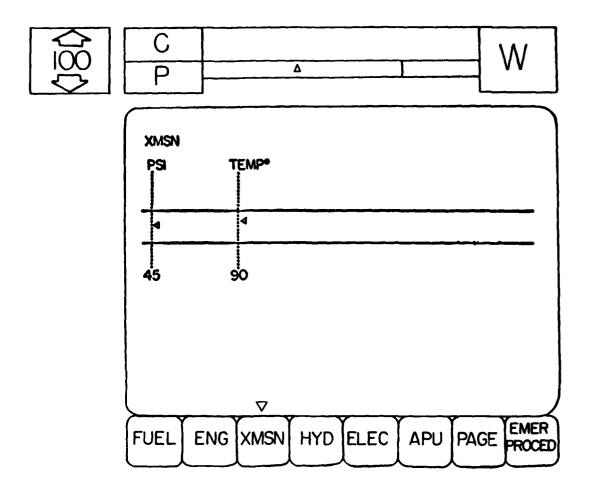
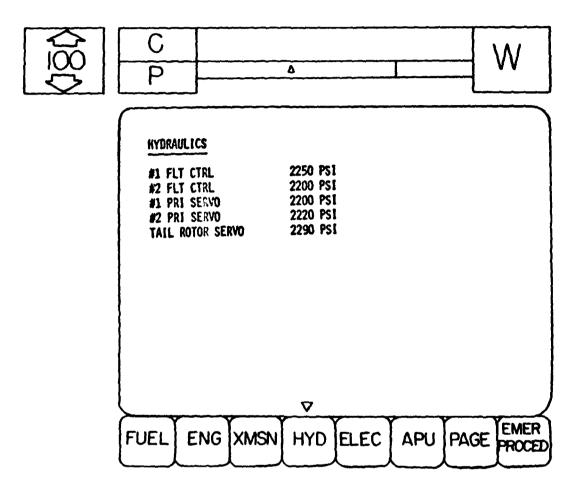


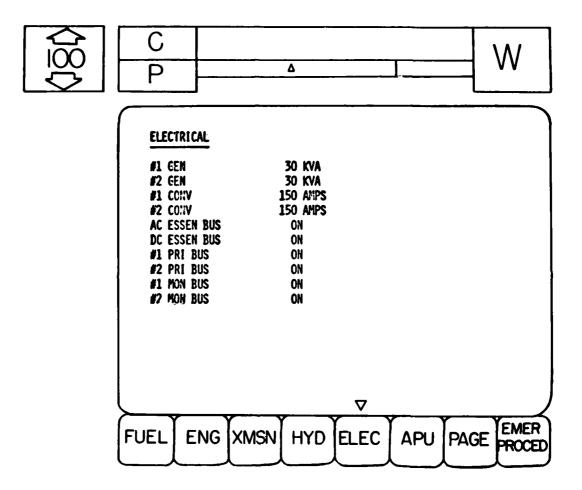
Figure 8. XMSN system display.



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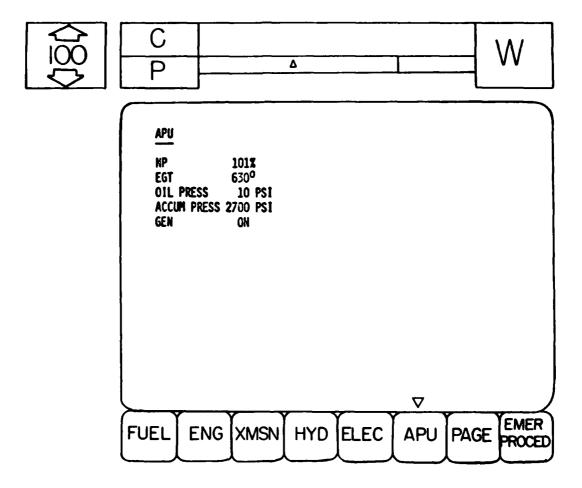
The HYDRAULICS system will be displayed only by manual access, though the status of individual parameters will be automatically displayed during caution conditions. No analog scales are displayed after manual access, and automatically displayed caution status messages do not include digital readouts.

Figure 9. Hydraulics system display.



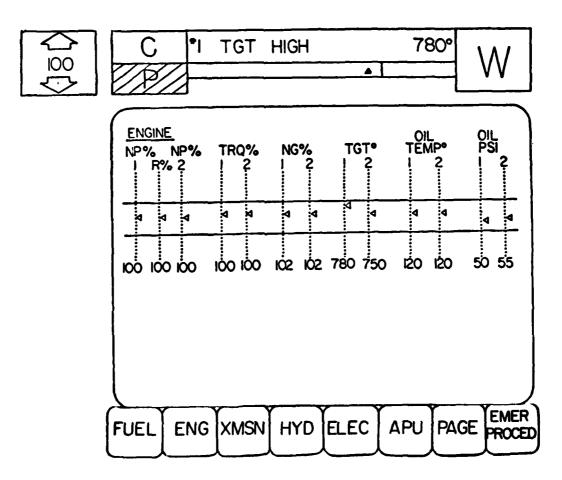
The ELECTRICAL system will be displayed only by manual access, though the status of individual parameters will be automatically displayed during caution conditions. No analog scales are displayed after manual access, and automatically displayed caution status messages do not include digital readouts.

Figure 10. Electrical system display.



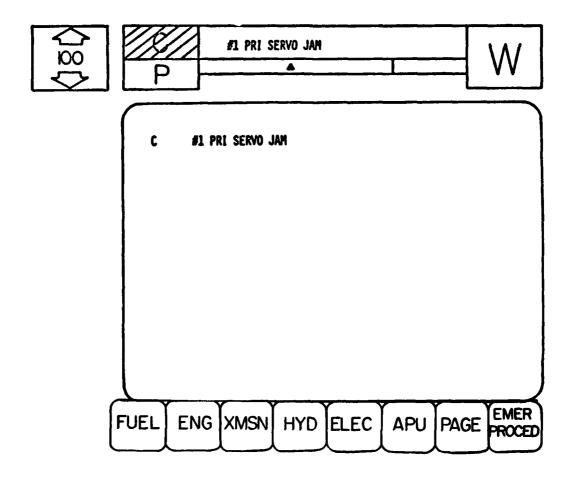
The APU system, like FUEL, ENG AND XMSN systems, will be automatically displayed when one of its parameters exceeds its limit, and may be manually accessed. No analog scales, however, are displayed for the APU system.

Figure 11. APU system display.



A #1 TGT HICH precaution condition has occurred. The precaution light is illuminated. The CWP display indicates the message with associated digital readout of status. The PMD cursor has moved toward the limit line. The entire engine system has been automatically displayed on the main screen, and the TGT cursor has moved vertically toward the limit line.

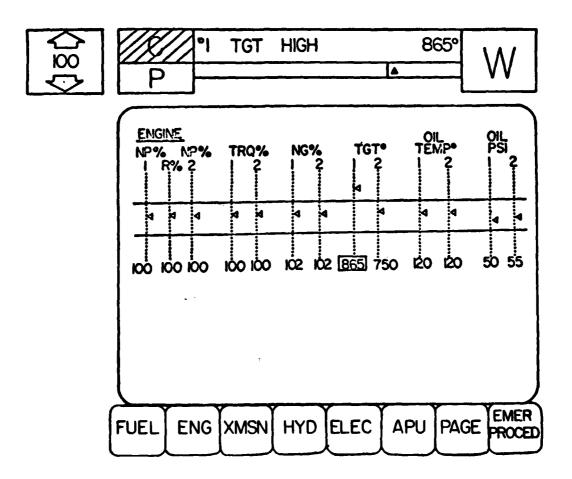
Figure 12. Sample precaution display.



There are two sets of caution messages: those that automatically call up display of the entire system of which they are a part, and those which are displayed alone. Distinctions are identified in Tables 27 through 30 in Appendix A. #1 PRI SERVO JAM does not call up the entire hydraulic system. Its caution message is displayed on both the CWP and main displays. It will remain on the CWP so long as it represents the highest priority message, or is temporarily replaced by a later message of lower priority, and will remain on the main screen until the condition is corrected.

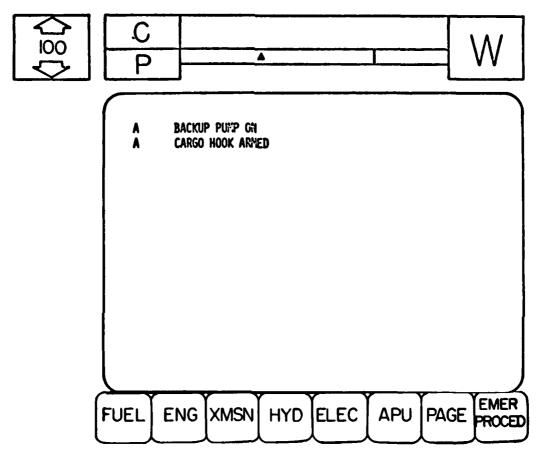
Figure 13. Sample caution display.

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A #1 TGT HIGH caution condition results in automatic display of the engine system on the main screen, where the TGT cursor has moved beyond the limit line and the TGT digital readout has been boxed to highlight the overlimit parameter. The caution light is illuminated. The message and associated digital readout has appeared on the CWP display. The CWP will include digital readout of a parameter if that parameter calls up an entire system on the main screen. The power management cursor has moved beyond the limit line.

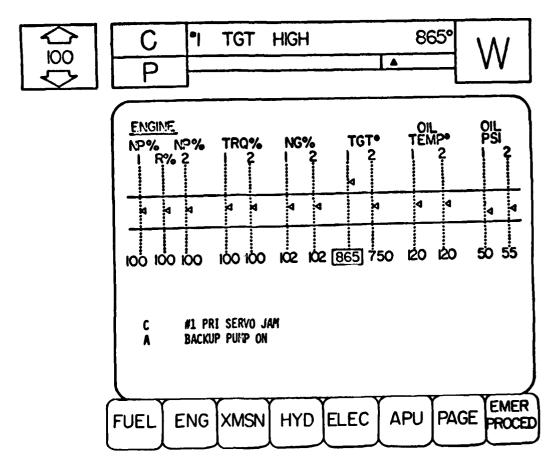
Figure 14. Sample caution display.



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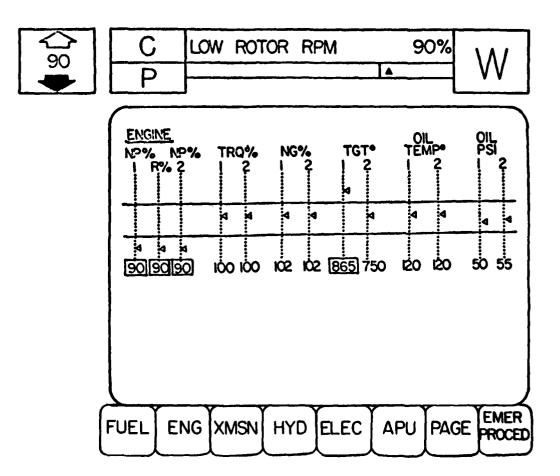
Advisory messages appear on the main screen only.

Figure 15. Sample advisory display.



The caution light has been reset. The #1 TGT HIGH message, with digital readout, has remained on the CWP display, since it constitutes the highest priority message and no other subsequent messages are pending. The PMD cursor has moved beyond the limit line. The engine system parameters have been automatically displayed on the SSM display. The #1 TGT cursor has moved vertically beyond the caution line, and the digital readout has been boxed to highlight the caution condition. Prior caution (#1 PRI SERVO JAM) and advisory (BACKUP PUMP ON) messages have been vertically prioritized on the SSM display.

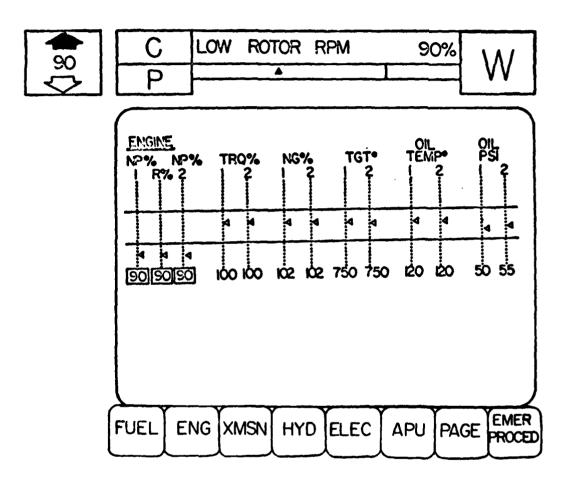
Figure 16. Illustration of prioritization.



A LOW ROTOR RPM warning has occurred. The warning light has been reset. The LOW ROTOR RPM message continues, with digital readout, on the CWP display. The dedicated NR display presents rotor speed digitally, and the arrow indicates that NR is decreasing. The engine system parameters have been automatically displayed on the main screen. The main display shows NR in combination with decreased NP, and a current but previously announced #1 TGT caution. All are boxed for highlight, and relevant cursors have moved beyond limit lines.

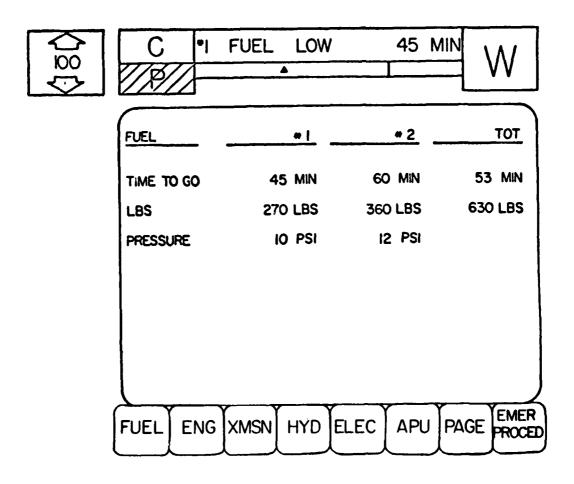
Figure 17. Sample LOW ROTOR RPM condition.

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Rotor RPM is at 90% and increasing beyond a specified rate.

Figure 18. LOW ROTOR RPM condition.

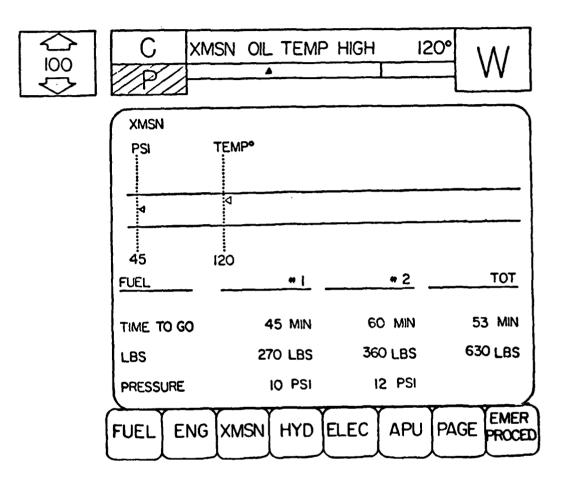


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LOW FUEL precaution limit has been preset at 45 minutes. Presetting of the LOW FUEL precaution limit has been accomplished through the peripheral keyboard, described later in Task V. Tank #1 has been depleted to this level. The precaution light has illuminated and the fuel system has been automatically displayed on the main screen.

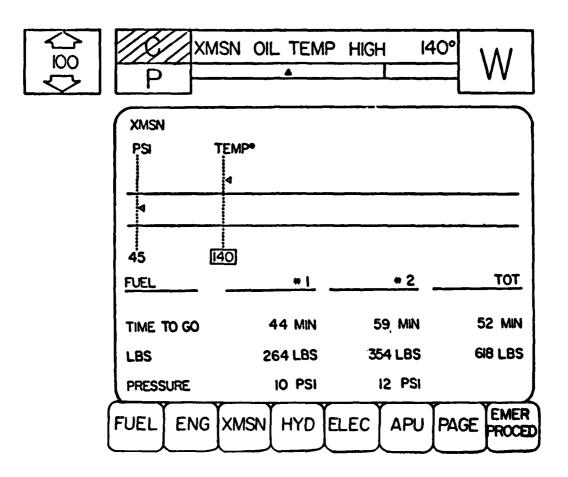
Figure 19. Sample scenario display.

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XMSN oil temperature has reached precaution limits. The precaution light has illuminated, and the XMSN OIL TEMP message and digital readout have appeared on the CWP display. On the main screen, the XMSN system has been automatically displayed, and the fuel system, which is in a lower priority, has moved down on the screen.

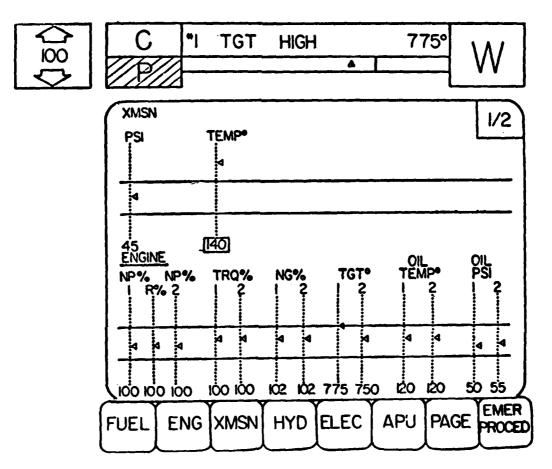
Figure 20. Sample scenario display.



XMSN oil temperature has reached the caution limit. The caution light has illuminated, and the XMSN OIL TEMP message and digital readout have been displayed on the CWP display. On the main screen, the XMSN TEMP digital readout has been boxed, and the cursor has moved above the limit line.

Figure 21. Sample scenario display.

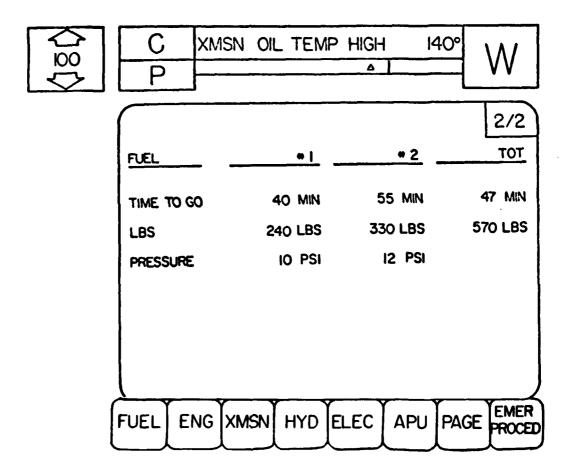
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#1 TGT has reached precaution limits. The precaution light has illuminated and the #1 TGT HIGH message and digital readout have appeared on the CWP display. The power management cursor has moved toward the limit line. On the main screen, the XMSN system, in a caution condition, maintains its priority. The engine system, of higher priority than the fuel system, has "bumped" the fuel system beyond the screen capacity. A "1/2" indication in the upper right hand corner of the main screen indicates that the first of two pages of screen information is currently displayed.

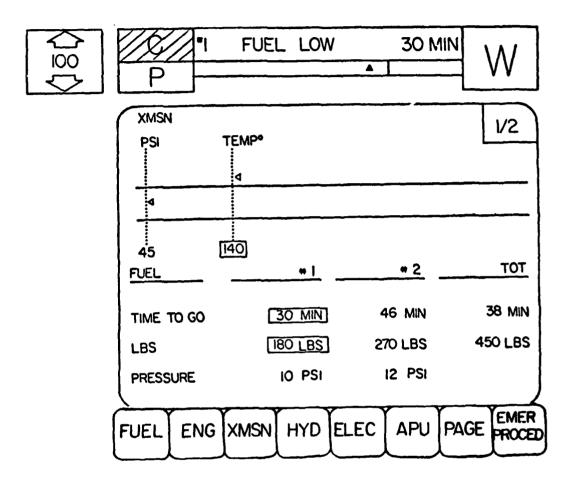
Figure 22. Sample scenario display.

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The precaution light has been reset. Page 2 of the main screen has been accessed by pressing the PAGE button. The XMSN OIL TEMP HIGH message remains of highest priority and is displayed on the CWP display. The power management cursor maintains its position. The "2/2" indication signifies that the second of two pages is being displayed.

Figure 23. Sample scenario display.

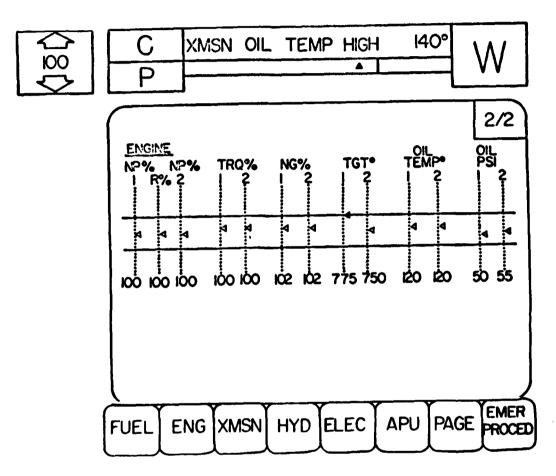


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#1 FUEL has now reached the caution level. The caution light has illuminated and the #1 FUEL LOW message and digital readout have appeared on the CWP display. The PMD cursor maintains its position. Since fuel is now in a caution condition while engine remains in a precaution condition, fuel has "bumped" engine to Page 2. Fuel #1 TIME TO GO and LBS readouts on the main screen have been boxed for highlight. Page 1 has been manually reaccessed.

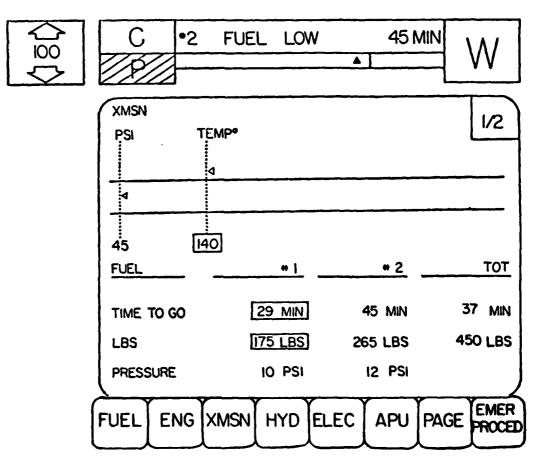
Figure 24. Sample scenario display.

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The caution light has been reset and the second page has been manually accessed. The XMSN OIL TEMP HIGH message remains of highest priority and has returned to the CWP display.

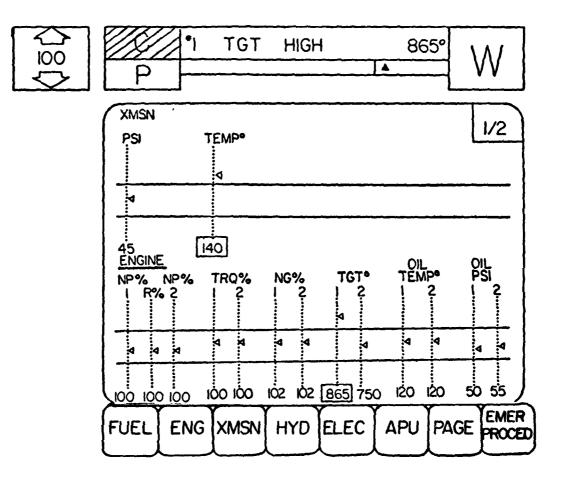
Figure 25. Sample scenario display.



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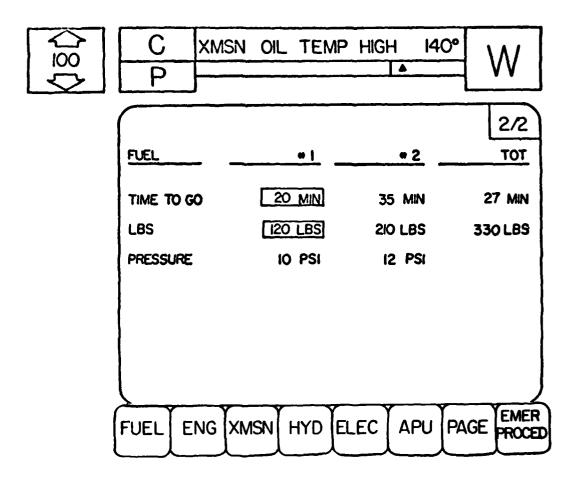
#2 FUEL has reached precaution level. The precaution light has illuminated, and the #2 FUEL LOW message and digital readout have appeared on the CWP display. Page 1 of the main screen has been manually accessed.

Figure 26. Sample scenario display.



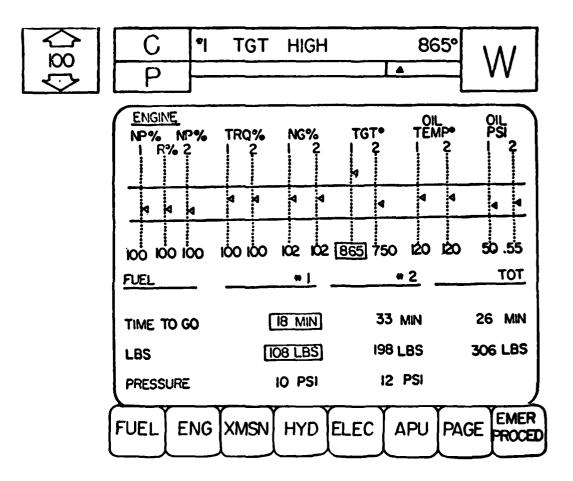
#1 TGT has reached caution limit. The caution light has illuminated and the #1 TGT HIGH message and digital readout have appeared on the CWP display. The PMD cursor has moved beyond the limit line. On the main screen, the engine system has "bumped" the fuel system to Page 2. The TGT digital readout has been boxed for highlight and the cursor has ascended beyond the limit line.

Figure 27. Sample scenario display.



The caution light has been reset, and Page 2 has been manually accessed. The XMSN OIL TEMP HIGH message and digital readout have returned to the CWP display. The PMD cursor has remained beyond the limit line.

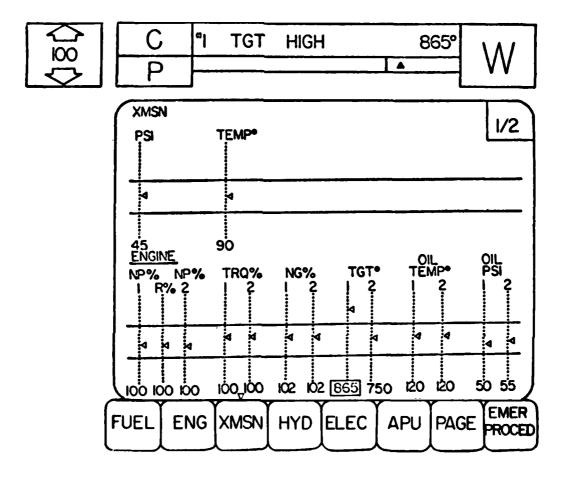
Figure 28. Sample scenario display.



The XMSN oil temperature has returned to within normal limits and has disappeared from the CWP and main displays. The #1 TGT HIGH condition is now of highest priority and is displayed on the CWP display. The PMD cursor remains beyond the limit line. Engine and fuel systems are prioritized and displayed on the main screen.

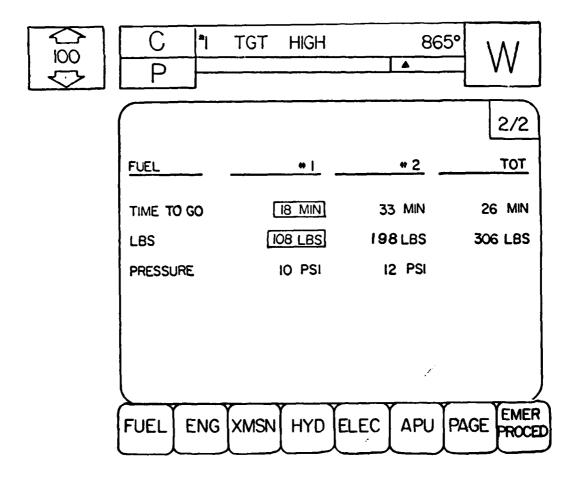
Figure 29. Sample scenario display.

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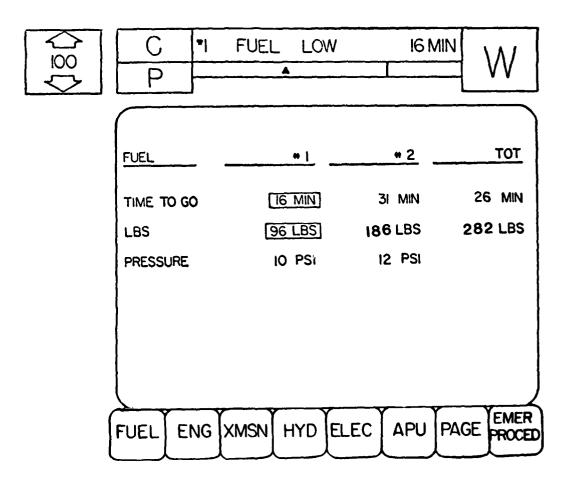
The XMSN system has been manually accessed and appears at the top of the main screen. A cursor above the XMSN button indicates the manual access. The fuel system has been "bumped" to Page 2, and a "1/2" indication has appeared. The #1 TGT HIGH message remains on the CWP display, and the PMD cursor remains beyond the limit line.

Figure 30. Sample scenario display.



Page 2 has been accessed, and the fuel system is displayed. A "2/2" indication has appeared. The CWP #1 TGT HIGH display and the PMD cursor remain unchanged.

Figure 31. Sample scenario display.



#1 TGT has returned to within normal limits, and TGT displays have disappeared from the CWP and main displays. There is no display overflow to a second page. The XMSN system has been removed from the main screen by a second depression of the XMSN button. Only the fuel system now involves exceedance. The #1 FUEL LOW message and digital readout appear on the CWP display, and the fuel system is displayed on the main screen.

Figure 32. Sample scenario display.

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Evaluation Of Control Allocation Concepts

"Control allocation" is a term referring to the decision-making algorithms by which a computer monitors system operation, decides when corrective response is required, and decides whether to perform the corrective response by itself or to inform the human operator of the condition, allowing him to perform the response. In advanced control allocation schemes, the computer adjusts its algorithms in a fashion analogous to human learning, by monitoring the consistency and effectiveness of the human operator's responses. In view of the long-term nature of such control allocation concepts and current pilots' preference for human as opposed to machine (computer) control over in-flight decision-making, control allocation was judged to be beyond the scope of the SSM as presently envisioned. It is, however, predicted that in the long term, control allocation concepts will be found more applicable to such functions as subsystem monitoring, and a detailed discussion of control allocation concepts is presented in Appendix C.

Determination Of Most Effective Means Of Displaying Emergency Procedures.

The display of emergency procedures in response to warning and caution conditions was investigated as a potentially useful feature of the SSM that would contribute to the reduction of crew workload and the enhancement of mission effectiveness. Helicopter pilots at Ft. Rucker, Alabama, ruled out a system logic that would display emergency procedures automatically in response to the occurrence of warning and caution conditions, but confirmed that an SSM feature permitting manual access of emergency procedures would reduce crew workload and enhance mission effectiveness. Though the SSM design includes an EMER PROCED button beneath the main screen for accessing emergency procedures, the mode of operation of the EMER button and related emergency procedures display formats are discussed in detail in Task V.

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TASK III: PRELIMINARY DESIGNS

Three preliminary designs of system architecture were prepared using the UH-60A as a case study. System unit functions will be discussed in detail for the first design, and features that differ for the second and third designs will also be discussed in detail.

The three preliminary designs were identified as follows:

- 1. Current: Technology is currently available for constructing all system components described, though some development would be required for the specific applications identified.
- 2. Near-term: It is predicted that the technology required for construction of some of the system components described will be available subsequent to development within 5-10 years.
- 3. Long-term: It is predicted that the technology required for construction of several of the system components described will not be available within 10 years.

Though the three designs have been distinguished by temporal labels, it must be noted that temporal predictions of availability of electronic technology are difficult at best. The development of flat panel display technology, for example, has lagged behind previous industry predictions, though imminent solutions are constantly being promised. The development of computerized voice interactive systems (speech recognition and speech synthesis) has involved sudden breakthroughs, though application problems currently exist whose solution time is difficult to predict accurately.

Fiber-optics data transmission is currently a reality, though aircraft applications of fiber-optics data bussing must still face such problems as signal loss and connector efficiency.

The difficulty of predicting the time factor is not limited to hardware. Though airborne computers are currently a reality, such problems as sensor failure analysis through systems modelling require powerful software programs whose development time is difficult to predict.

Therefore, although the three preliminary designs have been distinguished by temporal labels, they are best distinguished by their distinctive components. Were all required hardware and software currently available, the second design offers more mission effectiveness than the first, and the third more than the second.

CURRENT DESIGN

The architecture of the current design is presented in Figure 33.

Caution/Warning/Precaution Display (CWP Display)

C/W/P lights are provided for both pilot and copilot. Triggers for C/W/P lights are identified in Tables 35 through 38 in Appendix A. Caution and Warning lights are triggered by exceedance of predefined limits. The Precaution light is triggered by a combination of exceedance of predefined limit and rate of parameter movement toward a predefined caution limit. The predefined precaution limit for a FUEL LOW precaution may be redefined by pilot or copilot through the perpiheral keyboard described in Task V. Pilot and copilot CWP lights and displays are

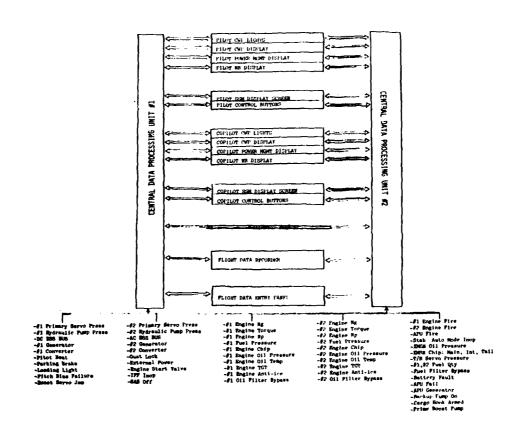


Figure 33. Current design architecture.

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interconnected, but redundant. Resetting of CWP lights by either crew member accomplishes resetting for the other crew member's display as well. CWP messages and their prioritization are defined in Tables 27 through 30 and 35 through 38 in Appendix A. Operation of the CWP display was illustrated in Task II.

Power Management Display (PMD)

A PMD accompanies each CWP display. Operation of the PMD was illustrated in Task II.

Rotor RPM Display (NR Display)

An NR display provides dedicated digital readout of NR to both pilot and copilot. Operation of the NR display was illustrated in Task II.

Main SSM Display Screen (SSM Display)

A Main SSM display is provided for both pilot and copilot, for the display of system-related parameters, prioritized CWP messages, manually accessed subsystem information, and peripheral information. Information displayed on the Main SSM display is itemized and prioritized in Tables 27 through 30 and 35 through 38 in Appendix A. Related system parameters are defined in Tables 27 through 30 and Tables 31 through 34 in Appendix A. Peripheral information and display formats are defined in Task V. Operation of the Main SSM display and associated screen control buttons was illustrated in Task II. Operation of a peripheral keyboard associated with the Main SSM display is illustrated in Task V.

Flight Data Recorder (FDR)

An onboard FDR will automatically record the following information whenever an out-of-tolerance condition occurs for parameters so identified in Tables 27 through 30 in Appendix A, and during the course of that condition: status of out-of-tolerance parameter, time of occurrence, duration of condition, and cumulative frequency of condition occurrence since most recent playback. In addition, for specified parameters the FDR will also record the condition of related parameters. Table 39 in Appendix A lists these parameters for the UH-60A. Recording is terminated when all related parameters have returned to within normal limits. Manually directed recording may be accomplished through a RECORD switch located on the peripheral Flight Data Entry Panel keyboard, and terminated by a second depression of the switch. It is anticipated that playback of recorded flight data will be accomplished through plug-in peripheral devices, though changes in the Flight Data Entry Panel could be made to allow for command of on-board playback on the Main SSM display.

Flight Data Entry Panel (FDEP)

The FDEP is a peripheral function device whose operation will be discussed in detail in Task V. A removable and stowable FDEP is provided for both pilot and copilot for entering and accessing data for performance

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calculations, checklists other than emergency procedures, and weight monitoring. The FDEP will be linked to the Central Data Processing Units through an electronic umbilical cord, when on-board, and may be used as a performance calculator during flight briefings, when unplugged.

Central Data Processing Units (CDPU's)

Two CDPU's will perform digital conversion of analog sensor signals, process digitized sensor data by comparison with preestablished limits, perform self-BIT and command BIT for displays, provide symbol generation for displays, provide prioritization logic for displays, provide displays and controls with data logic and synchrony, provide computation capability for performance monitoring, store checklists and procedures for display, scale simultaneously displayed analog formats and digital displays, provide commands and data to the FDR, and perform sensor failure analysis.

Sensor failure analysis will be performed through modelling procedures and/or sensor comparisons. For engine parameters, a mathematical model of the engine will be programmed into the CDPU's and all monitored parameters will be inserted into the model. Any parameter that does not conform to the model will be considered invalid and its sensor will be considered inoperative. Where practical, multiple redundant sensors will be used and by comparison of data received, the appropriate operating sensor will be selected. Sensor failures will be recorded by the FDR. Where failed sensors result in inability to report reliable messages to the crew, sensor failure will be announced. Prioritization of announced sensor failure messages will be identical to the warning or caution priority of the corresponding parameter.

Data Transmission

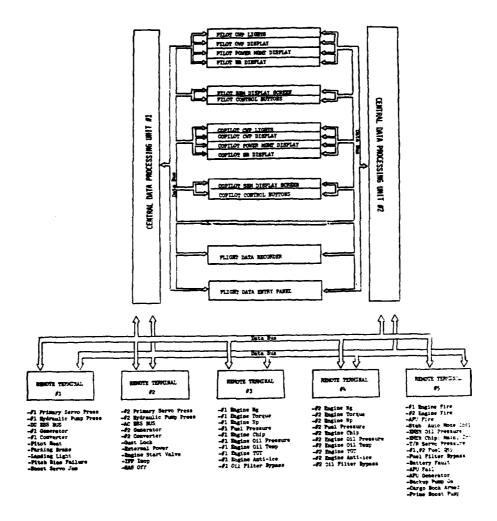
Signal sources for the UH-60A are included in Figure 33. Each sensor is wired directly to each CDPU. Where sensor failure analysis requires triply redundant sensors, this redundancy will be provided. Each CDPU is directly wired to each display and set of controls. In addition, CDPU's are interlinked, sharing functions and passing control.

NEAR-TERM DESIGN

Figure 34 illustrates system architecture for the near-term design.

Multiplexed electronic data transmission was employed in the nearterm design on the basis of the following predicted advantages of
multiplexing:

- 1. Improved reliability through redundancy, high reliability components, fewer components, and improved component derating and thermal design.
- 2. Reduced electromagnetic interference (EMI): Fewer and shorter wires mean less EMI pickup surfaces; simple two-wire busses can be easily and more extensively shielded; and pulsed digital signals are inherently less susceptible to EMI than conventional analog signals.
- 3. Enhanced maintainability: Multiplex systems continuously check the validity of transmitted and received signals and can be programmed to display discrepancies.



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Figure 34. Near-term design architecture.

- 4. Improved survivability: Redundant and separate units, reduced number of components, and fewer and shorter associated wiring results in an estimated 50% reduction of system-presented areas.
- 5. Improved flexibility: Software changes instead of extensive aircraft modifications required to add future systems; equipment can be located at optimum location for performance, balance, etc., without wiring constraints; and reconfiguration for specific missions is simplified.

The near-term design is identical to the current design with the exception of the use of multiplexed data bussing for data transmission and the inclusion of remote data processing terminals.

Remote Terminals (RT's)

Five RT's perform the following functions: analog to digital conversion of sensor signals, sensor failure analysis, data storage for transmission to CDPU's upon command, and BIT as commanded by CDPU's.

The internal system will be tested by programming the CDPU to insert test words periodically into the sensor inputs of the RT's. The RT's will process these test words as though they were received from the sensors. When the test word is received back at the CDPU, it will be compared to the test word sent, and any discrepancy will indicate a channel fault. The channel fault will be relayed to the FDR, and sensor data through that channel will not be accepted by the CDPU.

Data Transmission

Sensors are grouped and wired directly to their respective RT's. Data is transmitted between RT's and CDPU's through dual redundant electronic data busses. Data between CDPU's and all displays and controls, the FDR, and the FDEP is also transmitted through electronic data bussing. The bussing architecture is defined in Figure 34.

While Figure 34 represents the SSM as a closed system, it must be noted that both near-term and long-term data busses are likely to be shared with other aircraft systems, as are the CDPU's. It is beyond the scope of this effort to define these other systems or their interaction with the SSM.

LONG-TERM DESIGN

Figure 35 illustrates the system architecture for the long-term design. The long-term design is identical to the near-term design except for the use of fiber-optics data bussing for data transmission and the addition of auxiliary Voice Warning and Voice Recognition systems.

Data Transmission

In the long-term design, fiber-optics data bussing replaces the near-term electronic data bussing. Properties of fiber-optics data transmission are compared with properties of electronic data transmission in Table 40 in Appendix A.

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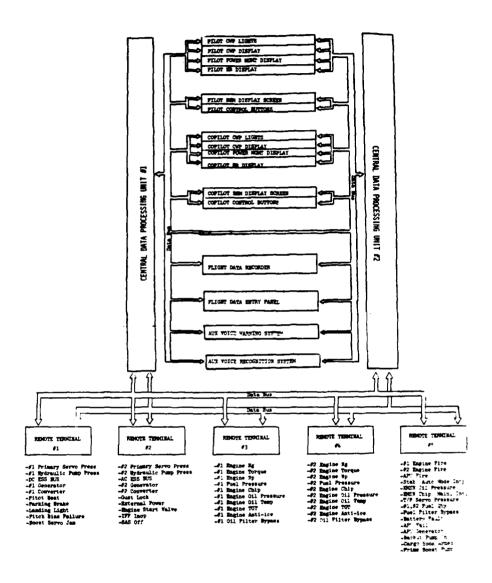


Figure 35. Long-term design architecture.

Auxiliary Voice Warning System (VWS)

An auxiliary VWS has been included as a unit in the long-term design. This unit would transmit prioritized voice warning messages by means of computerized voice synthesis. The VWS is suggested as auxiliary to the CWP display. It is envisioned that when experimental and simulation studies have determined the basic requirements for a synthesized VWS and have approved technology candidates, voice warning may serve as the primary system.

Auxiliary Voice Recognition System (VRS)

The VRS is a computerized system that recognizes and understands human speech and performs verbally commanded functions. Within the SSM, the VRS would follow verbal commands to reset CWP lights, display Main SSM display information, accept FDEP data inputs, and display commanded checklists and performance information. It is envisioned that the VRS could also interact with other aircraft controls to be determined in the future.

There is in fact no <u>requirement</u> in the SSM as designed for the pilot or copilot to employ manual controls, since the system functions automatically to monitor and display all essential information. The additionally included SSM display buttons and FDEP keyboard, which are intended for optional use during low workload conditions, do entail manipulation. Since current helicopter flight controls require use of both hands, any system that eliminates manual workload under any conditions is of potential value. The applications of the VRS to the SSM are therefore useful but limited, and the true value of a VRS must await design, experimental, and simulation studies determining the possible applications of a VRS to other control functions and the adequacy of VRS technology in addressing those applications.

SUMMARY OF SSM UNIT FUNCTIONS

Each of the designs described above includes displays that <u>replace</u> existing subsystem displays. The SSM is not intended as an auxiliary system, but rather as the primary system for monitoring and displaying the status of aircraft subsystems in a manner that reduces crew workload and enhances mission effectiveness, especially during high workload NOE flight.

The listing which follows identifies the units defined in the designs described above, and outlines their functions.

REMOTE TERMINAL (RT)

SENSOR INFORMATION GATHERING ANALOG TO DIGITAL CONVERSION DIGITIZED DATA STORAGE SENSOR FAILURE ANALYSIS BIT AS COMMANDED BY CDPU

CENTRAL DATA PROCESSING UNIT (CDPU)

DIGITIZED SENSOR DATA PROCESSING
SENSOR DATA COMPARISON TO PRE-ESTABLISHED LIMITS
PROVIDE BIT COMMANDS TO RT'S
PROVIDE COMPUTATION CABAPILITY
SUPPLY DATA TO FDR
PERFORM SELF-BIT FUNCTIONS
PROVIDE LOGIC FOR PRIORITIZED DISPLAYS
PROVIDE SYMBOL GENERATION FOR DISPLAYS
PROVIDE DATA, LOGIC, AND SYNCHRONY FOR DISPLAYS AND CONTROLS
STORE AND PROVIDE DATA AND LOGIC FOR FDEP

DISPLAYS

PRESENT CAUTION, WARNING, PRECAUTION, AND ADVISORY MESSAGES AND DATA AUTOMATICALLY PRESENT SUBSYSTEM STATUS INFORMATION WHEN COMMANDED MANUALLY PRESENT EMERGENCY PROCEDURES WHEN COMMANDED MANUALLY PRESENT FDEP COMMANDS AND DATA WHEN COMMANDED MANUALLY

FLIGHT DATA ENTRY PANEL (FDEP)

COMMAND PERIPHERAL FUNCTION DISPLAYS INPUT PERIPHERAL FUNCTION DATA

FLIGHT DATA RECORDER (FDR)

RECORD STATUS OF RELATED PARAMETERS DURING OVER/UNDER LIMIT CONDITIONS RECORD SENSOR FAILURES

AUXILIARY VOICE WARNING SYSTEM (VWS)

PROVIDE SYNTHESIZED VOICE WARNING AND CAUTION MESSAGES

AUXILIARY VOICE RECOGNITION SYSTEM (VRS)

INTERPRET HUMAN SPEECH AND COMMAND CDPU TO DISPLAY REQUESTED DATA

SCHEMATIZATION OF SYSTEM LOGIC

A block diagram of the Subsystem Status Monitor is presented in Figure 36. Figure 37 illustrates Warning/Caution light logic. Figure 38 illustrates CWP Display logic. Figure 39 illustrates Power Management Display logic. Figure 40 illustrates NR Display logic. Figure 41 illustrates rate sensing logic for the Precaution light. Figure 42 illustrates the Main SSM Screen logic. Figure 43 illustrates fuel monitoring logic. Figure 44 illustrates the logic of the Flight Data Recorder. Figure 45 illustrates the logic governing internal system testing.

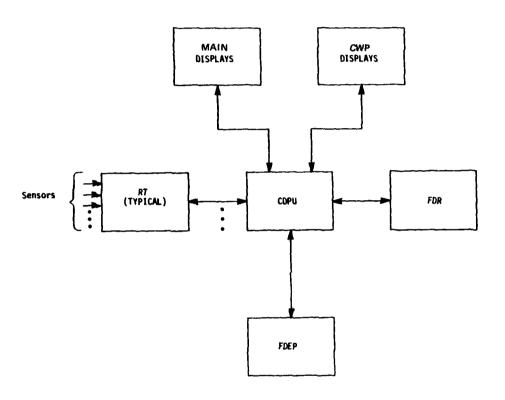


Figure 36. Subsystem Status Monitor block diagram.

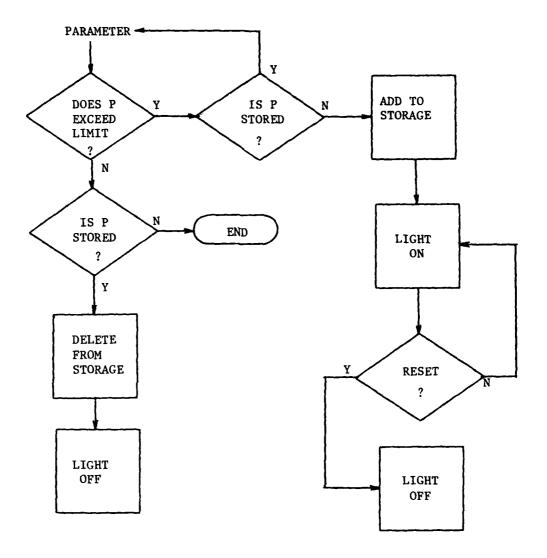
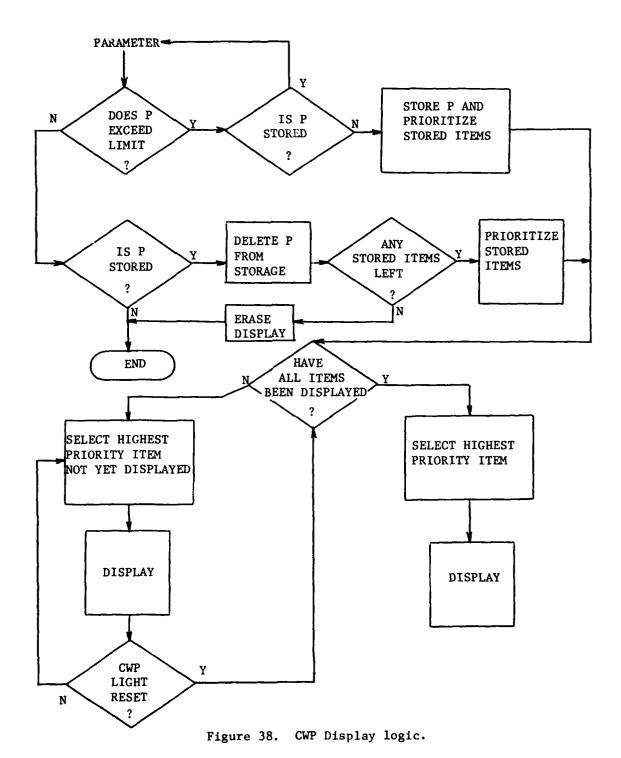


Figure 37. Warning/Caution light logic.



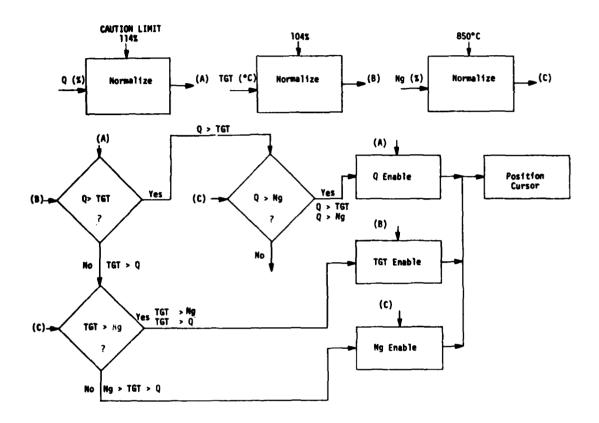


Figure 39. Power Management Display logic.

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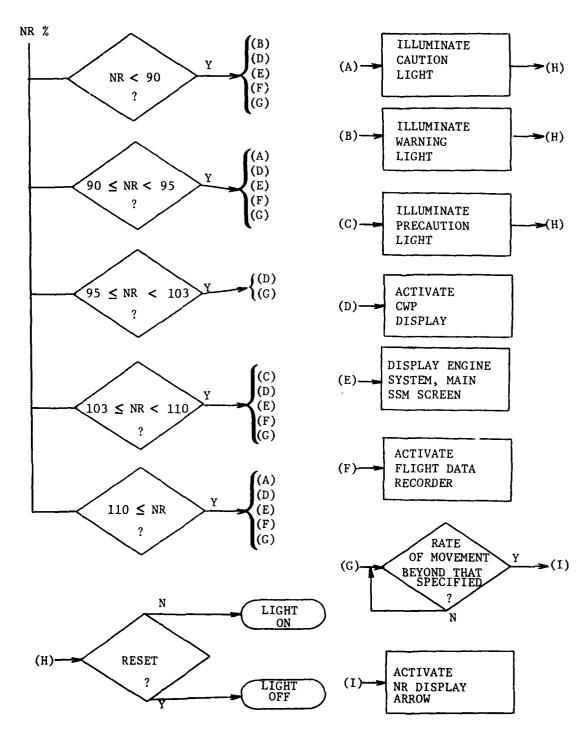


Figure 40. Rotor Speed logic.

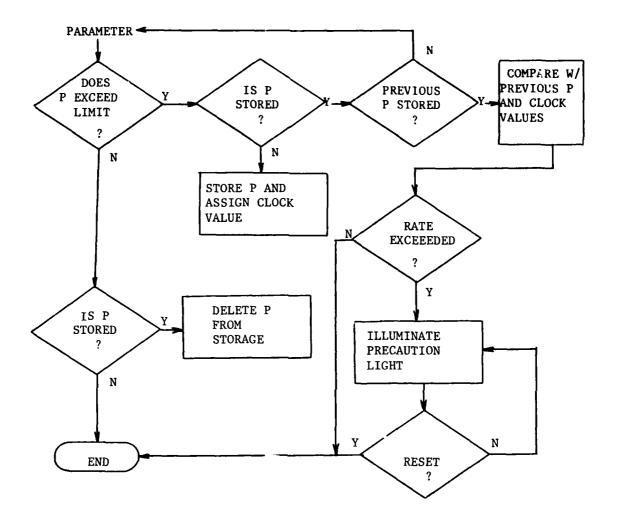
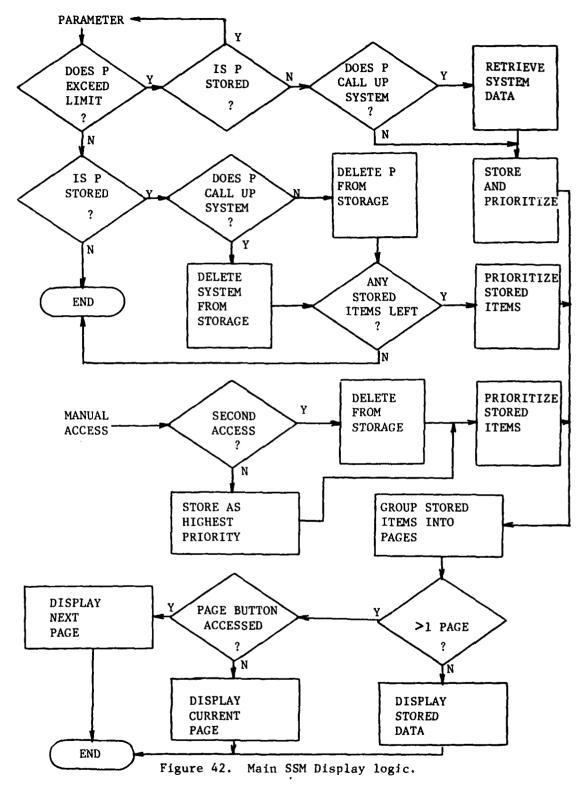


Figure 41. Precaution light logic.



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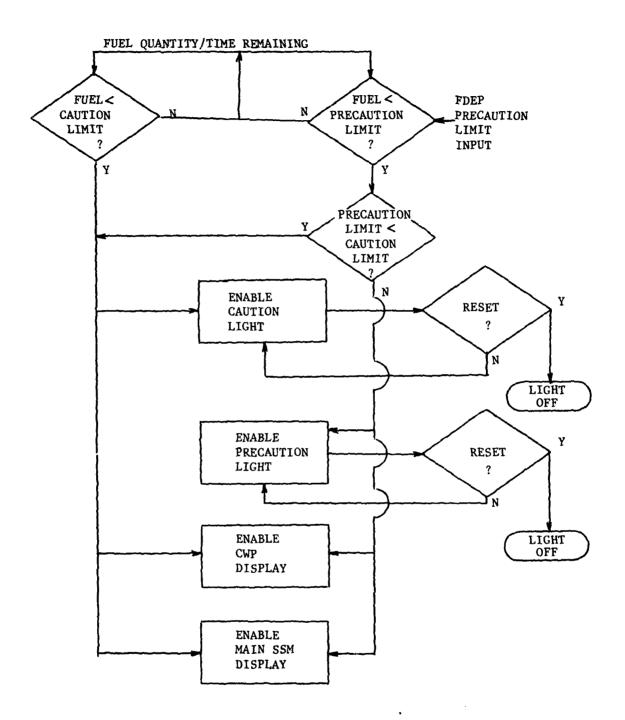


Figure 43. FUEL LOW logic.

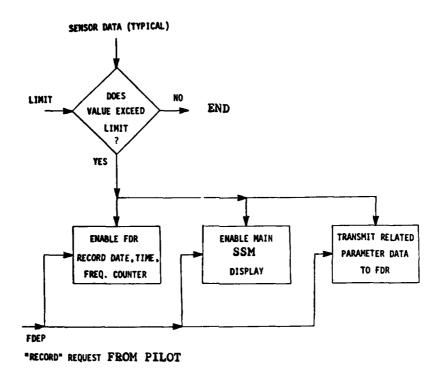


Figure 44. Flight Data Recorder logic.

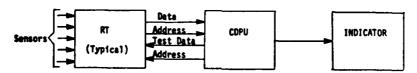


Figure 45. Internal system testing logic.

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TASK IV: EVALUATION OF DESIGNS

The preliminary designs developed during Task III were submitted for evaluative review to specialists in the areas of: flight safety; crew workload; aircraft space, volume, and weight; reliability and maintainability; survivability and vulnerability; and life cycle cost estimation. Summaries of these evaluations follow.

FLIGHT SAFETY

The following points were highlighted during flight safety evaluation:

- 1. The CWP display will greatly enhance out-of-cockpit visual attention during NOE flight.
- 2. If collimation of the CWP display could be achieved, the resulting removal of the requirement to refocus night vision goggles would enhance flight safety, especially during NOE flight.
- 3. The capability of performing sensor failure analysis in advance of message display is likely to considerably enhance flight safety by reducing the frequency of falsely aborted missions.
- 4. The greatest advantages of the SSM appear during workload extremes. Under high workload flight conditions, in-cockpit eye time is reduced; under low workload conditions, peripheral functions may be utilized.
- 5. Though performed independently, evaluations of reliability, maintainability, and survivability/vulnerability will impact flight safety considerations.
- 6. Finalized flight safety evaluation would benefit from experimental and in-flight evaluations of human performance. Human reliability testing of any eventual hardware is recommended.
- 7. Efficient training and relearning techniques will be an essential feature contributing to flight safety when an SSM is eventually put to applied use.

CREW WORKLOAD

A thorough workload analysis would require experimental investigation involving functional hardware, with provisions for measuring secondary task performance, physiological indices of stress and fatigue, and subjective evaluations of users. In the absence of hardware, the current workload analysis was rudimentary and limited to reexamination of task analyses and to evaluation of design features by comparison with workload reduction guidelines typically applied to evaluation of displays and display controls.

Task sequences for subsystem monitoring during a #1 ENGINE OIL PRESSURE LOW condition were compared for existing and SSM configurations. Under existing configurations, a crew member would be required to perform the following tasks:

- 1. Note caution light.
- 2. Press to reset.

- 3. Scan caution/advisory panel.
- 4. Identify condition.
- 5. Scan instruments.
- 6. Interpret #1 ENG OIL PSI value.
- 7. Intermittent repetition: steps 3,4,5,6.

For the same condition under the SSM configuration, the crew member would be required to:

- 1. Note caution light.
- 2. Read CWP screen.
- 3. Press to reset.
- 4. Intermittent repetition: step 2.

The SSM sequence is shorter than the existing sequence and improves by comparison over time, and steps 7 (existing) and 4 (SSM), which entail intermittent monitoring, are repeated. The comparison also improves in proportion to the amount of other required workload.

The UH-60A Operational Sequence Diagrams (OSD's) were reviewed and the number of different tasks performed by pilot and by copilot during each minute of a representative flight profile were tabulated. The OSD's listed subsystem monitoring as a discrete task, and it was counted as such in the tabulation. Minute-by-minute tabulation was reviewed and subsystem monitoring tasks were deleted, according to the following rationale: the existing system requires intermittent monitoring of instruments to determine whether parameters are approaching limits; the SSM does not, and the task may therefore be deleted. Figure 46 compares the number of tasks performed by pilot and copilot under existing and under SSM configurations for each minute of a three-leg flight profile that includes flight to pickup zone, flight to landing zone (including NOE), and return to base.

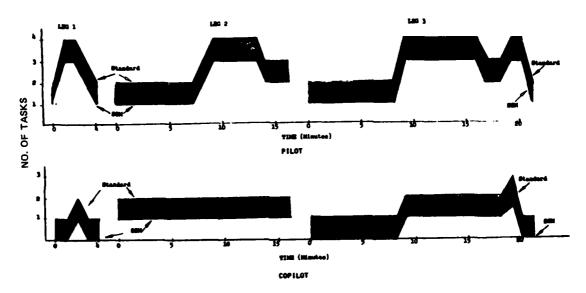
Figure 47 presents Figure 46 data as percentage of tasks reduced through employment of the SSM design. It will be noticed that every minute of the flight profile entails workload reduction by this analysis, and that at several points the copilot workload is reduced by 100%.

Table 41 in Appendix A lists salient features of the SSM which promise to reduce crew workload during the monitoring of helicopter subsystems. The matrix compares SSM features with workload elements. This analysis is conceptual, and each cell of the matrix is susceptible to further experimental analysis. The future conduct of such experimental evaluations is highly recommended during the development of any hardware for eventual applications.

SPACE, VOLUME, AND WEIGHT

The following points were highlighted during space and volume evaluations:

- 1. The replacement of current dedicated displays (dials, gages, and caution/advisory panel) by the multi-function SSM displays will result in a saving of instrument panel space.
- 2. The FDEP, VWS, and VRS will result in increased volume requirements within the cockpit.
 - 3. The CDPU's, FDR, and RT's are likely to require additional volume,



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Figure 46. Flight profile comparison of existing (standard) vs. SSM configuration workload. Comparisons are based upon data from the UH-60A Operational Sequence Diagrams.

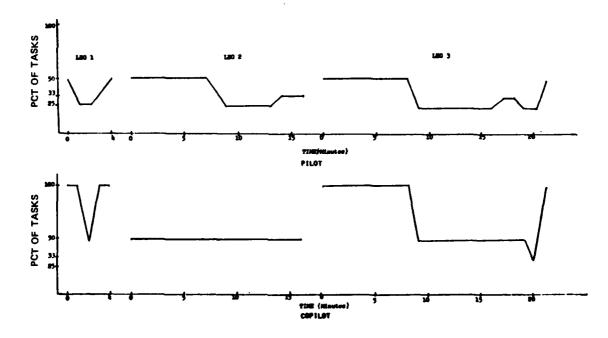


Figure 47. Percentage of tasks reduced through application of the SSM. Data based upon UH-60A Operational Sequence Diagrams.

though this will be offset to the extent that computer technology succeeds in achieving further miniaturization.

- 4. Designs including multiplexed data transmission will result in reduced wiring.
- 5. Center of gravity considerations will be important when designing for installment of any eventual hardware.

An estimate of the weight of each unit of each preliminary design was made. The weight of each existing unit in each helicopter that would be replaced by the SSM units was also estimated. Insofar as the CDPU's are not likely to be restricted to SSM usage, their weights were not included in the evaluation. Estimated weights of units replaced were subtracted from estimated weights of SSM units to be installed for each helicopter and for each preliminary design. The resulting delta estimates are presented in Table 42 in Appendix A.

Table 42 suggests that the weight analysis proves more favorable for the aircraft that currently include the greatest amount of instrumentation and wiring (UH-60A and CH-47C) and less favorable for the aircraft with less instrumentation and wiring (OH-58C and AH-1G). It should be noted that the weight estimates for SSM displays and RT's were conservatively based upon assumption of CRT's for the SSM main display and currently available RT technology. It may be fair to assume that technological development will provide either CRT's of reduced weight or feasible flat panel displays, and greatly reduced RT weights in the future. In this case, it may be predicted that the SSM will result in weight savings for both the UH-60A and the CH-47C for near-term and long-term designs. It should also be noted that the sharing of data transmission busses and/or displays by the SSM and other systems will result in reduced overall aircraft weight.

RELIABILITY AND MAINTAINABILITY

The following points were highlighted during reliability and maintainability evaluations:

- 1. The SSM designs result in fewer system components, a factor contributing to enhanced reliability.
- 2. The SSM designs involve considerable component derating, a factor contributing to enhanced reliability.
- 3. Component reliability is subject to change as near-term and long-term technology is developed. Given the factors of reduced number of system components and component derating, where SSM component reliability matches existing component reliability, overall reliability will be improved.
 - 4. Extensive BIT capability will improve maintainability.
 - 5. Modular construction will improve maintainability.
- 6. The data storage and analysis and growth capability of the FDR will result in improved maintainability.
- 7. The SSM is likely to permit standardization of parts across helicopter fleets. This parts standardization will greatly enhance maintainability.



SURVIVABILITY/VULNERABILITY

The following points were highlighted during the survivability/vulner-ability evaluation:

- 1. The redundancy of CDPU's and displays satisfies survivability requirements. For designs employing RT's, it is recommended that sensor inputs be conveyed to more than one RT per sensor.
- 2. The long-term design employing fiber-optics data transmission will result in significantly improved tolerance to both weaponry and electromagnetic interference.
- 3. Unit locations and shielding will have to be considered when any SSM is installed.

LIFE CYCLE COSTS

Life cycle cost estimates were made for the UH-60A. Investment costs (development, production, and initial spares) and operating and support costs (fuel, preventive maintenance, unscheduled maintenance, and replenishment spares) were estimated and totaled for the existing design and for the near-term and long-term SSM designs. Totals for existing design were subtracted from totals for the SSM designs, yielding delta estimates. The resulting delta estimates for the UH-60A are presented in Table 43 in Appendix A, which assumes a fleet of approximately 1100 helicopters, and constant 1979 dollars. Estimates do not include the CDPU's, since it was assumed that the CDPU's will not be restricted to the SSM system.

Life cycle cost estimates must be qualified by the following considerations:

- 1. All life cycle cost estimates are necessarily rough, in the absence of well-defined hardware.
- 2. Operating and support costs were not driving factors in the results yielded. Rather, production and installation costs were the predicted driving factors. These production and installation estimates were based upon conservative expectations, and it must be hypothesized that actual production and installation costs will be lower than estimated.
- 3. Since production and installation costs are the predicted driving factors, any standardization of units across fleets of different types of helicopters will result in considerable reduction of life cycle costs, a factor not input into the current evaluation.
- 4. In the absence of experimental data, no attempt was made to include improvements in mission effectiveness achievable through the SSM in the current analysis of life cycle costs. A thorough treatment of the life cycle costs presented must include consideration of any improvements in mission effectiveness achieved through workload reduction, inclusion of peripheral functions, and potential contribution to an integrated advanced cockpit.
- 5. It is predicted that weight and complexity factors will favor the UH-60A and the CH-47C to a greater extent than the OH-58C and the AH-1G, and life cycle cost estimates are likely to prove more favorable for the UH-60A and CH-47C than for the OH-58C or AH-1G.



SUMMARY OF ADVANTAGES AND DISADVANTAGES

The following major advantages of the SSM were identified during the evaluations of the SSM designs: crew workload reduction; flight safety enhancement; reduction in instrument panel space requirements; improved reliability and maintainability through component derating, use of fewer components, sensor failure analysis, internal system testing, flight data recording, and standardization of parts across fleets; simplified reconfiguration; addition of peripheral functions; growth capacity; and potential integration with other display and control systems.

Both life cycle cost and weight estimates were made upon conservative expectations of near-term and long-term technological progress. Based upon these conservative expectations, both life cycle cost and weight deltas were generally positive, but favored the UH-60A and CH-47C over the AH-IG and OH-58C. Before categorizing the life cycle cost and weight factors as disadvantages, the qualifications attached to these evaluations and presented in the discussions above should be considered.

TASK V: IDENTIFICATION OF PERIPHERAL FUNCTIONS

During Task V peripheral functions which might be performed by the SSM were identified, a Flight Data Entry Panel (FDEP) for data input and display access of peripheral functions was designed, and formats for the display of peripheral information were defined.

Figure 48 illustrates the Flight Data Entry Panel designed. Approximating a hand-held calculator in dimensions, the FDEP is designed as a stowable keyboard for the input of performance data and the access of peripheral function displays, which will appear on the SSM main display. The FDEP operates either independently of the main SSM display for preflight calculations in the briefing room, or in conjunction with the main SSM display through an umbilical cord in the aircraft. When acting independently of the main system, the FDEP is self-powered and programmable for Technical Manual calculations. When connected to the main system, the stored calculations and data in the CDPU's are updated by the programmed FDEP inputs. Operation of the keyboard during flight will be described in connection with associated peripheral displays.

The top row of keyboard buttons are used to access checklists which are displayed on the main SSM screen. Depression of the CKPT CHECK button calls up the display of a cockpit checklist illustrated in Figure 49. Depression of the APU START button calls up the APU start checklist illustrated in Figure 50. Depression of the ENG START button calls up the Engine Start checklist illustrated in Figure 51. The Before Takeoff checklist illustrated in Figure 52 is an appendix to the Engine Start checklist and automatically appears at the end of the Engine Start checklist. Depression of the HIT CHECK button calls up the Hit Check display illustrated in Figure 53. The Hit Check display combines command statements (e.g., "Establish 60% Torque") with TGT status indications derived from comparison of TGT sensor inputs against stored limits. Taken together, the checklist buttons and displays replace the analogous portions of the Technical and Flight Operator's manuals.

The second row of buttons on the FDEP accesses performance calculation displays on the SSM main screen. All performance calculation displays require data input through the FDEP. Display formats distinguish between input data and resulting information by the size of letters and by an input prompt. In the case of the Takeoff performance calculation, whose display is illustrated in Figure 54 and accessed by depression of the TAKEOFF button, Pressure Altitude, FAT, and Gross Weight require data inputs. Each would be succeeded by a prompt character on the screen until data is input. Crew members may base performance calculations upon either currently sensed or predicted variables. If the crew member desires to input data which is currently sensed or which has been previously stored, he may do so by simply depressing the CURR button. If, for example, the crew member wished to input "current pressure altitude" as a basis for performance calculation, and the current pressure altitude were 2000 ft., then a depression of the CURR button would result in an input of 2000 ft. for pressure altitude and a display of 2000 ft. pressure altitude. If the crew member desires to input data which is not currently sensed or previously stored, he would respond to the input prompt by depressing

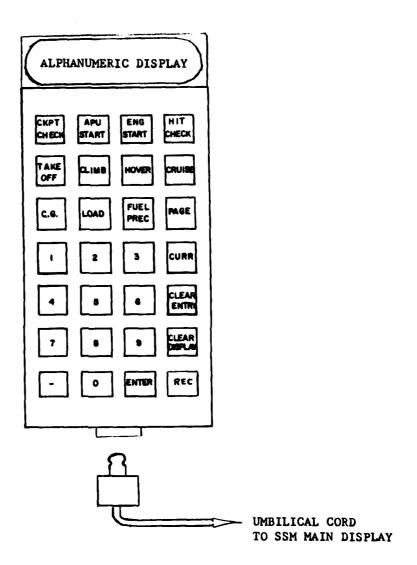


Figure 48. Stowable Flight Data Entry Panel.

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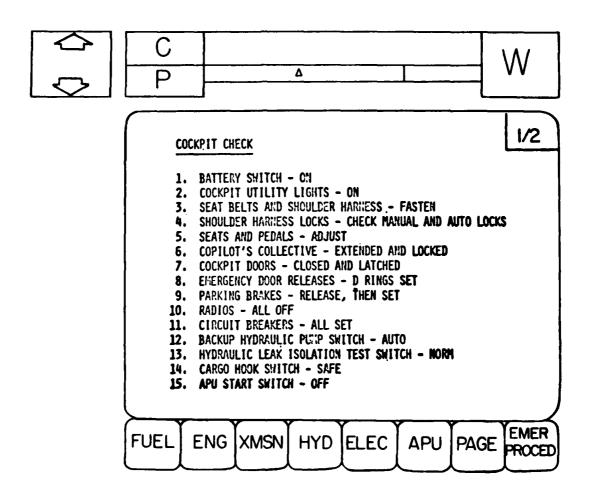


Figure 49. Cockpit Check display.

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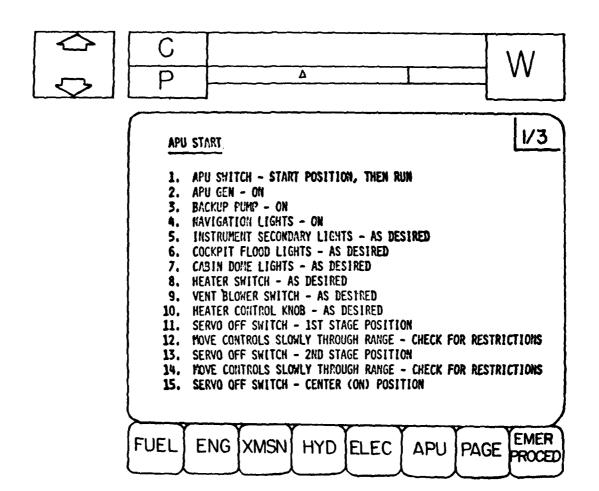


Figure 50. APU Start display.

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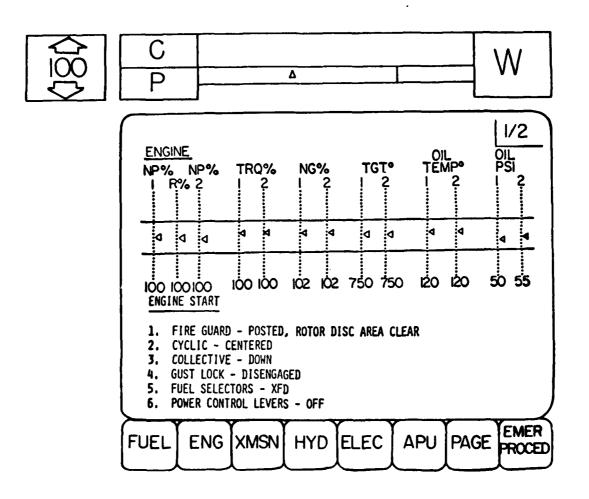


Figure 51. Engine Start display.

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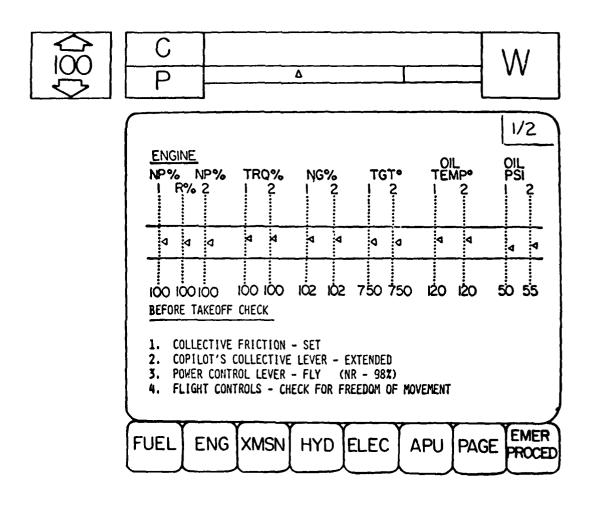


Figure 52. Before Takeoff Check display.

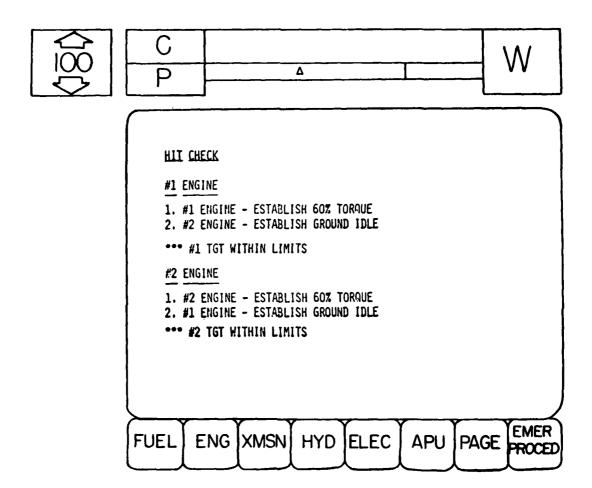


Figure 53. Hit Check display.

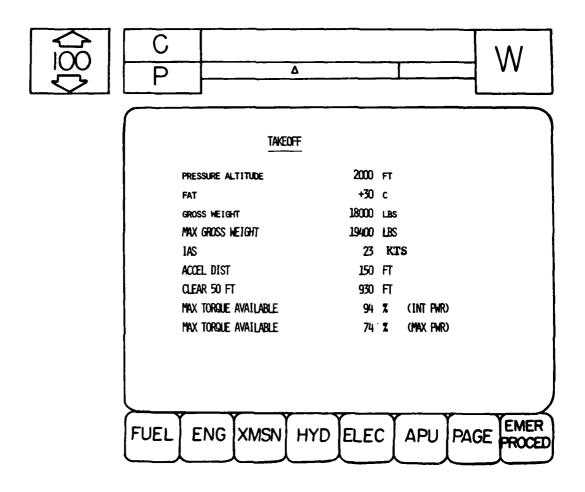


Figure 54. Takeoff performance calculations.

the appropriate digit buttons. When the input is correct and complete, depression of the ENTER button enters the input data. Depression of the CLEAR ENTRY button erases from memory and display the last digit appearing on the display. In the case of the Takeoff display illustrated in Figure 54, the items from Max Gross Weight through Max Torque Available have been automatically calculated on the basis of the data input and the performance calculation information and algorithms stored in memory. Depression of the CLIMB button calls up the Climb display illustrated in Figure 55. Depression of the HOVER button calls up the Hover display illustrated in Figure 56. Depression of the CRUISE button calls up the Cruise display illustrated in Figure 57. Taken together, the performance calculation displays and inputs replace the performance calculation workload currently required in referencing the analogous portions of the Flight Operator's Manuals. It is believed that the flight phase and CURR input features of the FDEP represent novel contributions to the state of the art of performance calculation panels.

Depression of the C.G. button calls up the CG display illustrated in Figure 58. The CG display provides a qualitative indication of the relation between current center of gravity and forward and aft limits, as well as digital readouts of current CG, forward limit, and aft limit.

Depression of the LOAD button calls up the Hook Load display illustrated in Figure 59. The Hook Load display provides a qualitative indication of the hook loads for two cargo hooks (FWD and AFT) by reference to limits, and a digital readout of load in pounds for each hook.

Depression of the FUEL PREC button calls up a display of the current setting of the fuel precaution limit. The limit may be reset by depression of the digital keys, followed by depression of the ENTER button. The fuel precaution limit may be set higher or lower than the caution limit. As illustrated in the fuel logic diagram in Figure 43, when the precaution limit has been set higher than the caution limit a precaution condition will trigger the precaution light, and when the precaution limit has been set lower than the caution limit a precaution condition will trigger the caution light.

When the FDEP is in use and the SSM main screen indicates that information to be displayed exceeds screen capacity, paging may be accomplished by depression of the PAGE button on the FDEP.

FDEP accessed displays will automatically be relegated to a priority lower than that of caution, warning, precaution or advosory information and lower than the displays accessed by depression of the system buttons associated with the SSM main screen. The REC button activates the FDR. A second depression of the button deactivates the recorder unless an automatic actuation of the FDR has been commanded by the CDPU's.

ACCESS OF EMERGENCY PROCEDURES

Interviews with instructor pilots at Ft. Rucker, Alabama, confirmed the desirability of providing optional access to display of emergency procedures. While pilots insisted that emergency procedures should not be displayed automatically in conjunction with caution or warning messages since this would impose additional workload when displays were

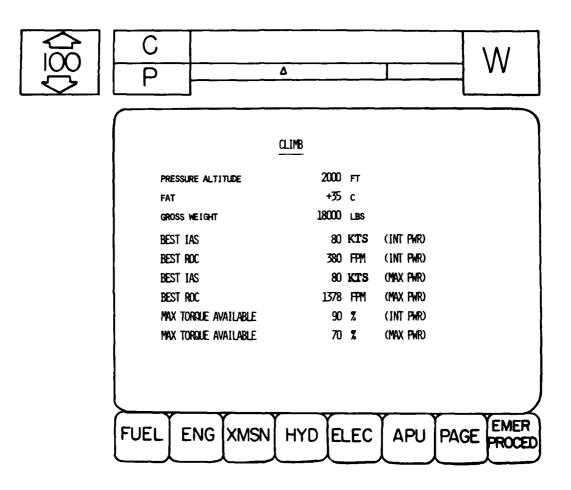


Figure 55. Climb performance calculations.

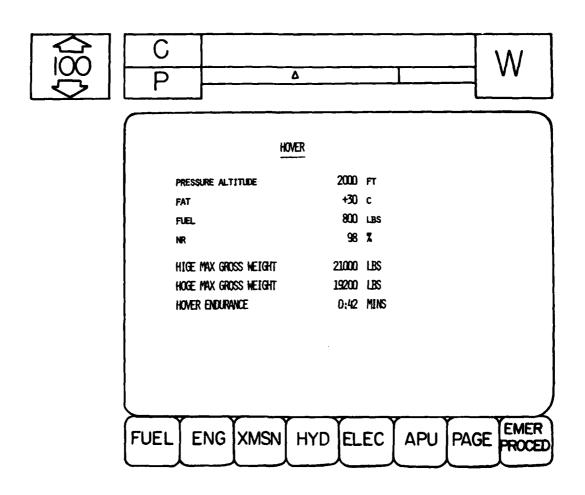


Figure 56. Hover performance calculations.

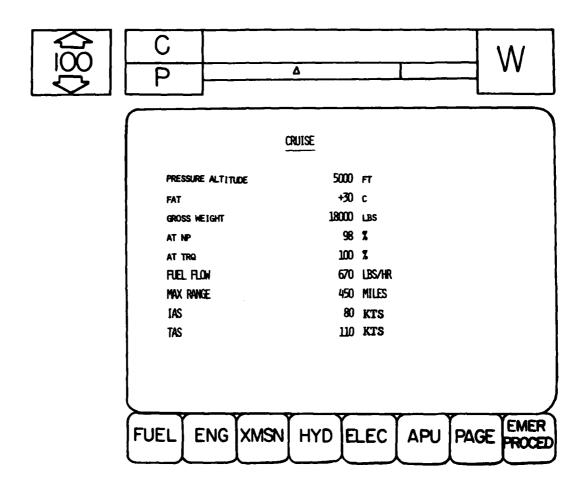


Figure 57. Cruise performance calculations.

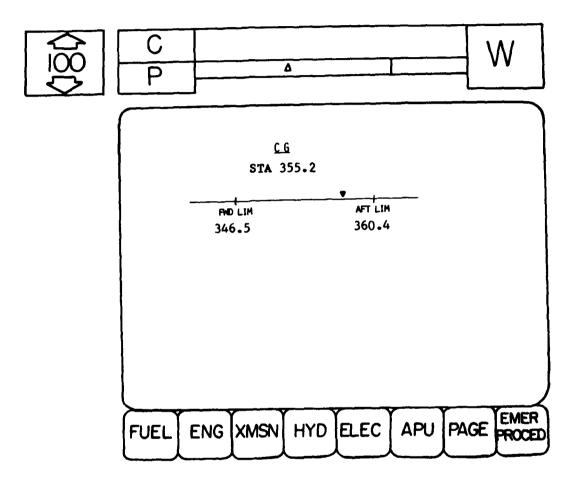


Figure 58. Center of Gravity display.

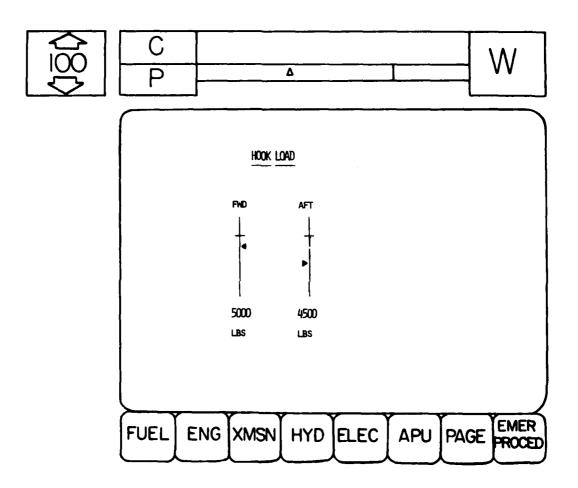


Figure 59. Hook Load display.

unnecessary, they did recommend ready access to any display controls for manual callup of emergency procedures. On this account, emergency procedures display access was not included in the FDEP, but was instead designed into the button row associated directly with the SSM main display. Figure 60 illustrates a sample Emergency Procedures display, accessed by depression of the EMER PROCED button. At any given moment, there are two subsets of emergency procedures: those associated with parameters currently out of tolerance, and those associated with parameters that are not currently out of tolerance. Crew members are more likely to desire access to emergency procedures associated with parameters which are out of tolerance. A single depression of the EMER PROCED button accesses automatically the emergency procedures associated with parameters currently out of tolerance. These parameters are prioritized, and the associated emergency procedures are displayed in prioritized fashion, until screen capacity is exceeded. Where paging is required, it is accomplished by depression of the PAGE button. A second depression of the EMER PROCED button clears the display of emergency procedures. Depression of a system button (FUEL, ENG, etc.,) immediately following depression of the EMER PROCED button will erase display of emergency procedures associated with out-of-tolerance parameters and switch mode to display emergency procedures for all parameters associated with the accessed system, in order of parameter priority. Where required, paging is accomplished by depression of the PAGE button. A second depression of the EMER PROCED button erases the display of emergency procedures.

OTHER PERIPHERAL FUNCTIONS

Several peripheral functions associated with aircraft maintenance have been discussed under the Preliminary Designs section, including flight data recording and playback. Though not included in the design, the following possibilities for maintenance peripherals have been identified through interviews with maintenance personnel: utilization of SSM displays and computer memory storage for presentation of troubleshooting trees onboard the aircraft; storage of maintenance data onboard the aircraft, where it is anticipated that the aircraft will be maintained in different locations at different times (while such storage might include time-line item replacement recording, it was not recommended that the aircraft serve as the sole storage location for maintenance data); and inclusion of provisions for integration of various additional sensors with the FDR for diagnostic testing.

The following peripheral applications to student flight training were identified: use of the FDR to record student responses to system events, and use of the CDPU's to program ground-based simulation exercises. In tandem aircraft, the SSM might be especially useful for instructor monitoring of student responses to system events through the SSM main screen and use of the main screen for student monitoring of instructor-provided prompts. It is anticipated that recording of student responses to system events will require additional sensors as well the use of the SSM display for instructor monitoring of student responses. It is also anticipated that allowing for instructor prompts, displayed to the student through the SSM main screen, will require an additional keyboard or console.

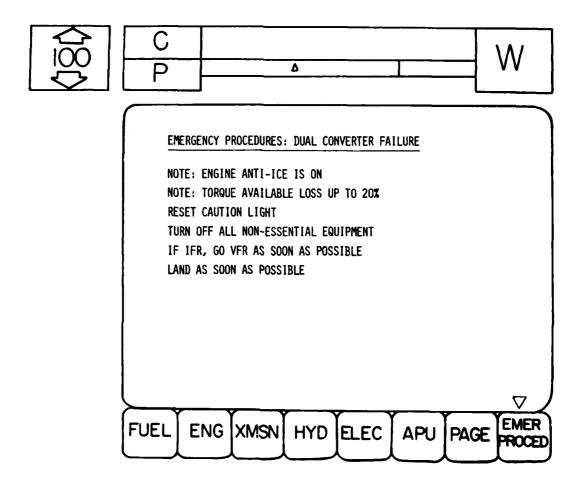


Figure 60. Emergency Procedures display.

Contract to

In all cases the potential use of the SSM for training of student pilots highlights the flexibility inherent in the SSM design. This flexibility of programming feature will in general facilitate the following: inclusion of additional system models for improved sensor failure analysis and diagnostics, as they become available; inclusion of additional sensors as they become available, with allowances for easy reprioritization; alteration of emergency procedures, checklists, and performance calculation data bases and algorithms; redefinition of precaution, caution, and warning limits; inclusion of automated responses as they become available; reconfiguration of helicopters for different missions; and integration of the Subsystem Status Monitor with other systems under development within the framework of the Army's extensive efforts to design, test, and construct a reduced workload and more mission-effective helicopter cockpit.

OF THE

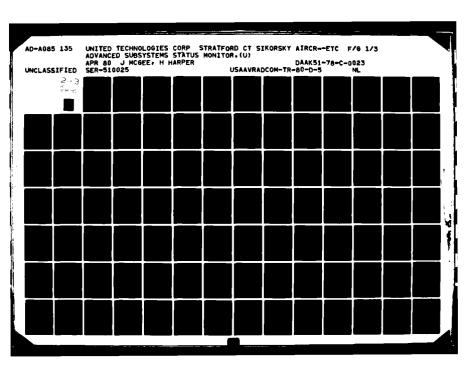
CONCLUSIONS AND RECOMMENDATIONS

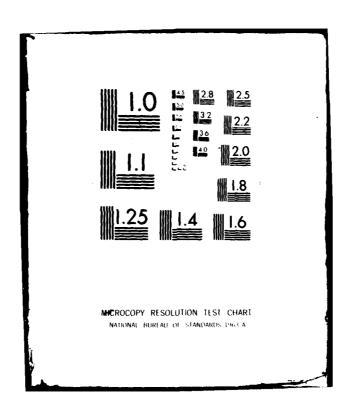
The following general conclusions may be drawn from the foregoing report:

- 1. The display-by-exception philosophy currently governing the display of many subsystem parameters displayed via caution/warning panels in helicopters can be viably extended to include other subsystem parameters currently displayed via dedicated instruments. Exceptions to this rule are main rotor speed, which should be continually displayed, and power management parameters, which should be combined into a single power management analog indicator.
- 2. A separate logic governing the display of parameters under differing mission phases or environmental conditions is not required.
- 3. The advanced Subsystem Status Monitor (SSM) defined in the foregoing report will reduce crew workload, improve mission effectiveness, enhance reliability, maintainability, and survivability/vulnerability, permit standardization of parts across helicopter fleets, and accommodate subsystem growth and increasing complexity.
- 4. The impact of the SSM designs discussed upon life cycle costs and aircraft weight will be more favorable for aircraft of large weight and complexity in their subsystems.

The following general recommendations may be drawn from the foregoing report:

- 1. The display logic and formats discussed should be submitted to experimental evaluation to determine quantitatively their impact upon human performance and reliability before incorporation into any hardware applications based upon the designs presented.
- 2. While voice synthesis and recognition appear to represent long-term solutions to the problem of information input/output under NOE helicopter flight conditions requiring constant manual control of the helicopter and visual attention to the outside world, the topic of computerized voice interaction should be studied carefully to determine the most effective applications of this emerging technology.
- 3. Any hardware development of the SSM designs presented should be complemented by a repetition of reliability, maintainability, survivability/vulnerability, aircraft weight, life cycle costs, safety, and human workload/reliability evaluations.
- 4. The interaction of the SSM with other designs aimed at cockpit integration should be studied.





APPENDIX A: TABLES 1-43

Tables 1-8 summarize subsystem parameters obtained from the UH-60A, CH-47C, OH-58C, and AH-1G operator's manuals. Tables 9-12 summarize cross-comparisons of UH-60A, CH-47C, and AH-1G parameters. Tables 13-16 present the results of an information requirements analysis. Tables 17-20 constitute the preliminary formatting of an information requirements questionnaire that was later submitted to Army pilots. Tables 21-24 present composite responses to the pilot questionnaire. Table 25 presents a cross-comparison of parameters by subsystem. Table 26 lists the major signal source devices used in the four helicopters studied. Tables 27-30 summarize the display logic for each helicopter. Tables 31-34 present data on automatic displays and multiple accessing. Tables 35-38 present prioritized listings of items of information for each helicopter. Table 39 shows the relationship of parameter groups. Table 40 compares the properties of data transmission cables. Tables 41 and 42 evaluate workload reduction and weight savings attributable to the SSM. Table 43 presents SSM life cycle cost estimates for the UH-60A.

TANKS AND SO

TABLE 1. UH-60A PAKAMETERS CURRENTLY DISPLAYED VIA ANALOG INSTRUMENTS.

SUBSYSTEM	PARAMETER	RANGE	NORMAL OF BANK	PRECAUTION LIMITS	NORWAL OF BAND PRECAUTION LIMIT! MALFUNCTION LIMITS INDICATOR	INDICATOR	STGWAL SOURCE	PARAMETER TYPE
FUEL 1 FUEL 2	FUEL QUANTITY 1 FUEL QUANTITY 2	0-1500 LBS	200-1500 LBS	0-200 LBS	•	Vertical Scale	Tank Unit Capacitance Probes	Analog
FUEL	TOTAL FUEL	0-3000 LBS	400-3000 LBS	0-400 TBS	•		Capacitance Probes	Analog
MAIN XMSN	XMSM OIL PRESSURE	0-190 PSI	35-65 PSI	25-35 PSI 65-130 PSI	Below 25 PSI Above 130 PSI	Vertical Scale	Variable Reluctance Sensor	Analog
MAIN XMSN	XMSN OIL TEMP	-50-160 ⁰ c	-50-120 ₀ c	120-140°C	Above 140 °C	Vertical Scale	Temperature Sensor	Analog
ENGINE 1 ENGINE 2	ENG 1 OIL TEMP ENG 2 OIL TEMP	-50-180 ⁰ c -150-180 ⁶ c	40-135°C 40-135°C	135-150°C 130-150°C	Above 150°C Above 150°C	Vertical Scale Vertical Scale	(Resistance Bulb- Thermostor)	Analog Analog
ENGINE 1	ENG 1 OIL PRESS	0-130 PSI	45-100 PSI	25-45 PSI	Below 25/Above	Vertical Scale	Transducer	Analog
EMGTNE 2	ENG 2 OIL PRESS	0-130 PSI	45-100 PSI	25-45 PSI	Below 25/Above 100 PSI	Vertical Scale	Transducer	Analog
POWER TURBINE 1 POWER TURBINE 2	TIT 1 TIT 2	0-1000°C 0-1000°C	0-775°C 0-775°C	775-850°C 775-850°C	Above 850°C Above 850°C	Vertical+Digital Vertical+Digital	(Thermocouple Harness Probe)	Analog Analog
POWER TURBINE 1 POWER TURBINE 2	- 2- 2- 2- 2- 2- 2- 2- 2- 2- 2- 2- 2- 2-	0-130% 0-130%	95-103% 95-103%	90-951/103-1101 90-951/103-1101	Below 90%/Above 1100 Below 90%/Above 1100	90%/Above 110% Vertical Scale 90%/Above 110% Vertical Scale	Dual Purpose Sensor Frequency Dual Purpose Sensor Frequency	r Frequency r Frequency
GAS GENERATOR 1 GAS GENERATOR 2	~ 2 ~ 2	0-110% 0-110%	386-0	98-104x 98-104x	Above 104% Above 104%	Vertical+Digital Vertical+Digital	Tach Pulse Sensor Tach Pulse Sensor	Frequency
ENGINE 1 ENGINE 2	* TORQUE E1 * TORQUE E2	0-145% 0-145%	0-104% 0-104%	104-114X 104-114X	Above 114% Above 114%	Vertical+Digital Vertical+Digital	Shaft Twist Sensor Shaft Twist Sensor	Analog Analog
MAIN ROTOR	ž	0-140%	95-103%	%56-06	Below 90%	Vertical Scale	Rotor Tachometer	Frequency
HAIN ROTOR	OVERSPEED	•	•	•	a 125% a 135% a 140%	Light Light Light	Rotor Tach Indicator Rotor Tach Indicator Rotor Tach Indicator	Indicator Frequency Indicator Frequency Indicator Frequency

TABLE	2. UH-60A PARAMETE	RS DISPLAYED VIA WARNI	Table 2. UH-60A PARAMETERS DISPLAYED VIA WARNING/CAUTION/ADVISORY LIGHTS.		
SUBSYSTEM	PARAMETER INDICATION	INDICATOR	EXPLAHATION	SIGNAL SOUNCE	PARAMETER TYPE
CAUTION	MASTER CAUTION	Master Caution Light	Advises that caution light is	Caution Panel	Discrete
GAS GENERATOR 1	#1 ENGINE OUT	Harning Light	Left engine N _G at or below 55%	Gas Generator Tach Sensor Discrete	Discrete
GAS GENERATOR 2	#2 ENGINE OUT	Warning Light	Right engine N _G at or below 55%	Gas Generator Tach Sensor	
ENG 1, ENG 2, APU	FIRE	Warning Light, T-Handle	Fire is detected in Engine I, 2 or ARUInfra-red Optical Sensor	Uinfra-red Optical Sensor	Discrete
MAIN ROTOR	LOW ROTOR RPM	Warning Light (Flashing) and steady advisable tone	Rotor RPM is below 95% NR.	Rotor Tachometer	Frequency Discrete
FUEL 1	FUEL 1 LOW	Caution Light	Tank level below 170-190 LBS	Capacitative Sensor	Analog.
FUEL 2	FUEL 2 LOW	Caution Light	Tank level below 170-190 LBS	Capacitative Sensor	Analog.
FUEL .	#1 FUEL PRESSURE	Caution Light	Left tank pressure below 8.5±0.5 PSI	Pressure Switch	Discrete
FUEL	#2 FUEL PRESSURE	Caution Light	Might tank pressure below 8.5+0.5 PSI	Pressure Switch	Discrete
#1 ENGINE OIL	#1 ENG OIL PRESSURE	Caution Light	Left engine oil pressure below 25 PSI Transducer	Transducer	Analog
#2 ENGINE OIL	#2 ENG OIL PRESSURE	Caution Light	Mght engine oil pressure below 25 PSI Transducer	Transducer	Analog
#1 ENGINE OIL	#1 ENG OIL TEMP	Caution Light	Left engine oil temp above 150°C	Thermistor	Analog
#2 ENGINE OIL	#2 ENG OIL TEMP	Caution Light	Right engine oil temp above 150°C	Thermistor	Analog
#1 ENGINE SCAVENGE	CHIP #1 ENGINE	Caution Light	Left engine: metal chip or particle buildup	Magnetic Detector	Ofscrete
#2 ENGINE SCAVENGE	CHIP #2 ENGINE	Caution Light	Right engine: metal chip or particle buildup	Magnetic Detector	Discrete
#1 FUEL FILTER	#1 FUEL FILTER BYPASS	Caution Light	7.5 PSID across left fuel filter	Mechanical Limit Switch	Discrete
12 FURE FILTER	#2 FUEL FILTER BYPASS	Caution Light	7.5 PSID across right fuel filter	Mechanical Limit Switch	Discrete
A1 ENGINE STARTER	#1 ENGINE STARTER	Caution Light	Left engine start valve open (Ng reaches 20%)	Pressure Switch	Discrete
42 ENGINE STARTER	#2 ENGINE STARTER	Caution Light	Right engine start valve open (Ng reaches 20%)	Pressure Switch	Discrete
#1 HYDRAULIC POMER	#1 PRI SERVO PRESS	Caution Light	First stage pressure below 2000 ± 50 PSI	Pressure Switch	Discrete
P2 HYDRAULIC POLER	62 PRI SERVO PRESS	Caution Light	Second stage pressure below 2000 ± 50 PSI	Pressure Saftch	Discrete

TABLE 2. CONTINUED.

		TYPE 7. CONTINUED.	UED.		
SUBSYSTEM	PARAMETER INDICATION	INDICATOR	EXPLANATION	SIGNAL SOURCE	PARANETER TYPE
#1 ENGINE GENERATOR	#1 GEN	Caution Light	Voltage: one phase below 95V or all Voltmeter above 105V	Voltmeter	Discrete
#2 ENGINE GENERATOR	/2 GEN	Caution Light	Current: 20 + 4 amp differential between transformers Frequency: below 370 + 4 Hz	Ampaieter	Discrete
# 1 CONVERTER	#1 CONV	Caution Light	No output from left converter	Relay Switch	Discrete
#2 CONVERTER	#2 CONV	Caution Light	No output from right converter	Relay Switch	Discrete
#1 ENGINE OIL	#1 OIL FILTER BYPASS	Caution Light	Left engine oil pressure at filter is 60-80 PSID	Mechanical Limit Switch	Discrete
#2 ENGINE OIL	#2 OIL FILTER BYPASS	Caution Light	Right engine oil pressure at filter is 60-80 PSID	Mechanical Limit Switch	Discrete
#1 HYDRAULIC PUMP	#1 HYD FUMP	Caution Light	Left hydraulic pump output pressure below 2000 \pm 50 PSI	Pressure Controlled	Discrete
#2 HYDRAULIC PUMP	#2 HYD PUMP	Caution Light	Right hydraulic pump output pressure below 2000 \pm 50 PSI	Mechanical Switch	Ofscrete
#1 HYDRAULIC POWER	#1 PRI SERVU JAM	Caution Light	Restricted pilot valve on first stage of one or more primary serves, or serve is in auto bypass	Pressure Controlled Mechanical Switch	Discrete Discrete
#2 HYDRAULIC POWER	#2 PRI SERVO JAM	Caution Light	Restricted pilot valve on second stage of one or more primary servos, or servo is in auto bypass	Pressure Controlled Mechanical Switch	Discrete
BOOST SERVOS	BOOST SERVO JAM	Caution Light	Yaw or collective servo pilot valve restricted	Pressure Controlled Mechanical Switch	Discrete
MAIN XMSN	CHIP MAIN XMSN	Caution Light	Metallic chip or particle Buildup	Magnetic Detector	Discrete
MAIN XMSH	MAIN XMSN OIL PRESS	Caution Light	XMSN of pressure below 14 ± 2 PSI	Pressure Switch	Discrete
AC POWER	AC ESS BUS OFF	Caution Light	No power being supplied to AC essential bus	Relay Switch	Discrete
BATTERY	BATT LON CHARGE	Caution Light	Battery charge below 41% of full charge state	20th Cell	Discrete
MAIN ROTOR	GUST LOCK	Caution Light	Gust lock not fully disengaged	Mechanical Switch	Discrete
PAIN XHSN	MAIN KHSN OIL TEMP	Caution Light	XMSM oil temperature above 112.8-121°C	Temperature Sensor	Discrete

		TABLE 2. CONTINUED.	CONTINUED.			
SUBSYSTEM	PARAMETER INDIGATION	INDICATOR	EXI	EXPLANATION	SIGNAL SOURCE	PARAMETER TYPE
FLT PATH STAB	FLT PATH STAB	Caution Light	E.	Failure within flight path stabilization system	FAS Computer	Discrete
DC POWER	DC ESS BUS OFF	Caution Light	S.	No power being supplied to DC essential bus	Relay Switch	Discrete
BATTERY	BATTERY FAULT	Caution Light	Sai	Safe operating temperature exceeded or call dissimilarity	Temp/Press Sensors	Discrete
PITCH BIAS ACT	PITCH BIAS FAIL	CautionLight	2	Pitch bias actuator malfunction	Pitch Bias Actuator	Discrete
HYDRAULIC	BOOST SERVO OFF	Caution Light	Ę	Pressure below 2000 + 50 PSI or off to yaw/collective boost servos	Pressure Switch	Discrete
STABILATOR	STABILATOR	Caution Light/Tone		Stabilator auto mode inoperative	Logic Network	Discrete
SAS	SAS OFF	Caution Light	š	SAS pressure below 2000 ± 50 PSI	Pressure Switch	Discrete
HYDRAULIC	TAIL ROTOR SERVO JAN	Caution Light	<u> </u>	Restricted pilot valve or in auto bypass mode	Pressure Switch	Discrete
APU	SEQUENCE FAIL APU	Caution Light	E.	Fails to accelerate from 5% to 70% in 60 seconds during start	Magnetic Pickup Tach	Discrete
APU	APU OVERSPEED	Caution Light	API	APU speed exceeds 110%	Magnetic Pickup Tach	Discrete
APU	APU UNDERSPEED	Caution Light	AP	APU speed drops below 90% after exceeding 90%	Magnetic Pickup Tach	Discrete
APU	APU EXHAUST TEMP HI	Caution Light	A .	APU exhaust temperature exceeds 660 ± 11°C	Temperature Sensor	Discrete
APU	APU OIL PRESS	Caution Light	A .	APU oil pressure below 6 ± 1 PSI, and speed above 90%	Pressure Switch	Discrete
IFF	IFF	Caution Light	₹	Mode 4 is being interrogated but is not responding	IFF Panel System	Discrete
#1 ENG ANTI-ICE	#1 ENG ANTI-ICE ON	Advisory Light		Left engine anti-ice switch on, valves open, or inlet temp exceeds 93°C	Switch, Temp Sensor	Discrete

Discrete

Switch, Temp Sensor

Right engine anti-ice switch on, valves open, or inlet temp exceeds 930c

Advisory Light

#2 ENG ANTI-ICE ON

#2 ENG ANTI-ICE

Advisory Light

APU GEN ON

₹

Discrete

Volt/Ameter

All phase above 105 V; less than 20 + 4 amp differential; above 370 + 4 Hz

TABLE 2. CONTINUED.

SUBSYSTEM	PARMETER INDICATION	IMDICATOR	EXPLANATION	SIGNAL SOURCE	PARAMETER TYPE
PITOT	PITOT HEAT ON	Advisory Light	Pitot heat switch is on	Switch	Discrete
HYDRAUL I C	BACKUP PUMP ON	Advisory Light	Backup pump pressure operating above 2000 ± 50 PSI	Pressure Switch	Discrete
PARKING BRAKE	PARKING BRAKE ON	Advisory Light	Parking brake handle has been pulled Mechanical Switch	Mechanical Switch	Discrete
CARGO HOOK	CARGO HOOK OPEN	Advisory Light	Hook load beam unlocked	Mechanical Switch	Discrete
CARGO HOOK	HOOK ARMED	Advisory Light	Cargo hook switch is at ARMED	Electrical Switch	Discrete
EXTERNAL PAR	EXT PUR CONNECTED	Advisory Light	AC external power connected and DC power is on battery bus	Jumper Wire	Discrete
INT XMSN	INT XMSN CHIP	Caution Light	Metal chip or particle buildup in intermediate gearbox	Magnetic Detector	Discrete
TAIL XPISH	TAIL XHSN CHIP	Caution Light	Metal chip or particle buildup	Magnetic Detector	Discrete
3	APU ON	Advisory Light	APU switch at RUN or START and above 15%	Switch, Magnetic Tach	Discrete
FUEL	PRINE BOOST PURP ON	Advisory Light	Switch at PRIME or BOOST, no Tabondle mailed	Switch	Discrete

TABLE 3. CH-47C PARAMETERS DISPLAYED VIA ANALOG INSTRUMENTS.

	4	ABLD OF CHI	TO FARAGELES	INDIA J. CR-4/C FARMEDERS PISCHAIED VIA ANALOS INSTRUCENTS.	MALLO LINGT NOTHING	• 67 1		
SUBSYSTEM	SUBSYSTEM PARAMETER	PANGE	HORMAL OP BAND	PRECAUTION LIMITS	MALFUNCTION LIMITS INDICATOR SIGNAL SOURCE	INDICATOR	SIGNAL SOURCE	PARMETER TYPE
FUEL	FUEL QUANTITY 1	0-2500 185	450-2500 LBS	0-450 LBS	•	140	Capacitance Probes	Analog
FUEL	FUEL QUANTITY 2	0-2500 LBS	450-2500 LBS	0-450 LBS	ı	Dia1	Capacitance Probes	Analog
FUEL	FUEL QUANTITY-TOT	0-5000 LBS	S81 000-006	0~900 LBS	•	Dfal	Capacitance Probes	Ana log
ENGINE 3	TORQUE 1	0-1300 LB/FT	0-890 LB/FT	ı	Above 890 LB/FT	Dial	Electric Torquemeter	Analog
ENGINE 2	TORQUE 2	0-1300 LB/FT	0-890 LB/FT	ı	Above 890 LB/FT	Dial	Electric Torquemeter	Analog
ROTOR	ž	0-290 RPM	223-233 RPM	204-223 RPH	Above 233 RPM	Dial	Tachometer	Frequency
GAS GEN 1	N _G 3	\$011-0	(MARKED FOR EACH ENGINE	H ENGINE	^	Dial	Tach Pulse Sensor	Frequency
GAS GEN 2	NG 2	0-110X	(MARKED FOR EACH ENGINE	H ENGINE	^	Dial	Tach Pulse Sensor	Frequency
ENG 1	ENG 1 OIL TEMP	3 ₀ 051-02-	-70-138 ⁰ c	•	Above 138°C	Dial	Binetallic Temp Probe	Analog
ENG 2	ENG 2 OIL TEMP	-70-150°C	-70-138°C	,	Above 138°C	Dial	Bimetallic Temp Probe	Analog
ENG 1	ENG 1 OIL PRESS	0-200 PSI	50-90 PSI	40-50 PSI/90-110 PSI	Below 40/Above 90 PSI	Dial	Pressure Trahsmitter	Analog
ENG 2	ENG 2 OILL PRESS	0-200 PSI	50-90 PS1	40-50 PSI/90-110 PSI	Below 40/Above 90 PSI	Dia)	Pressure Transmitter	Analog
XMSM	XMSN OIL TEMP	-70-150°C	-70-130 ⁰ C	130-140°C	Above 140°C	Dial	Temperature Probe	Anelog
XMSM	XHSN OIL PRESS	0-100 PSI	20-90 PSI	ı	Below 20/Above 90 PSI Dial	SI Dial	Pressure Transducer	Analog
HYDRAUL IC	FLT CTL PRESS 1	0-4000 PSI	2500-3200 PSI		Below 2500/Above 3200 PSI	Dial	Pressure Transmitter	Analog
HYDRAULIC	FLT CTL PRESS 2	0-4000 PS1	2500-3200 PSI		Below 2500/Above 3200 PSI	Dfal	Pressure Transmitter	Analog
HYDRAUL 1C	UTIL HYD PRESS	0-4000 PSI	2500-3400 PSI	•	Below 2500/Above 3400 PSI	Dial	Pressure Transmitter	Analog
ENGINE 1	E67 1	ე ₀ 0001-0	230-620 ⁰ c	•	Above 620°C	Dial	Thermocouple Probe	Analog
ENGINE 2	EGT 2	ე ₀ 0001-0	230-620 ⁰ C	•	Above 620°C	Dial	Thermocouple Probe	Analog
¥	AC LOADMETER	0-100g	1	•	٠	Offal	AC Gem Output	Analog
2	DC LOADNETER	0-100X	•	•	•	Dial	Rectifier Output	Anelog

ABLE 4. CH-47C PARAMETERS DISPLAYED VIA WARNING/CAUTTON LICHTS.

	TABLE 4. CH-47C	PARAMETERS DISPLAYE	LE 4. CH-47C PARAMETERS DISPLAYED VIA WARNING/CAUTION LICHTS.		
SUBSYSTEM	PARAMETER INDICATION	INDICATOR	EXPLANATION	SIGNAL SOURCE	PARMETER TYPE
CAUTION	MASTER CAUTION	Master Caution	Advises that caution light is illuminated	Caution Panel	Discrete
#1 ENGINE	#1 ENG 01L LOW	Caution Light	Less than 2 qts usable oil in #l oil tank	Indicator Microswitch	Discrete
#2 ENGINE	#2 ENG 011 LOW	Caution Light	Less than 2 qts usable oil in #2 oil tank	Indicator Microswitch	Discrete
#1 ENG/XMSN	#1 ENG CHIP DET	Caution Light	Metallic particles in #1 eng oil or XMSN	Magnetic Det, Elec Grid	Discrete
#2 ENG/XMSN	#2 ENG CHIP DET	Caution Light	Metallic particles in #2 eng oil or XMSN	Magnetic Det, Elec Grid Discrete	Discrete
FUEL	L FUEL PRESS	Caution Light	Left fuel pressure below 10 PSI	Pressure Switch	Discrete
FUEL	R FUEL PRESS	Caution Light	Right fuel pressure below 10 PSI	Pressure Switch	Discrete
XMSN	XMSN 01L HOT	Caution Light	Indicated temperature needs $130^{\circ}\mathrm{C}$	Indicator Microswitch	Discrete
XMSN	XMSN OIL PRESS	Caution Light	Indicated pressure less than 20 PSI	Indicator Microswitch	Discrete
XMSN	XMSN CHIP DET	Caution Light	Metal particles in oil of aft com- bining XMSN or aft vertical shaft thrust bearing	Magnetic Switch	Discrete
HYDRAULIC	#1 HYD BOOST OFF	Caution Light	#1 Fit ctl hyd press below 2000 PSI	Pressure Switch	Discrete
HYDRAULIC	#2 HYD BOOST OFF	Caution Light	#2 Fit ctl hyd press below 2000 PSI	Pressure Switch	Discrete
#1 SAS	#1 SAS OFF	Caution Light	#1 SAS locked out by EMER REL SAS Switch	SAS Panel Microswitch	Discrete
#2 SAS	#2 SAS OFF	Caution Light	#2 SAS locked out by EMER REL SAS Switch	SAS Panel Microswitch	Discrete
#1 GEN	#1 GEN OFF	Caution Light	#1 GEN inoperative or switch at OFF	Relay Switch	Discrete
#2 GEN	#2 GEN OFF	Caution Light	#2 GEN inoperative or switch at OFF	Relay Switch	Discrete
#1 TRANSFORMER	#1 RECT OFF	Caution Light	#1 Transformer - Rectifier has failed	Reverse Current Cutout	Discrete
#2 TRANSFORMER	#2 RECT OFF	Caution Light	#2 Transformer - Rectifier has failed	Reverse Current Cutout	Discrete

TABLE 4. CONTINUED.

SUBSYSTEM	PARMETER INDICATION	INDICATOR	EXPLANATION	SIGNAL SOURCE	PARMETER TYPE
#1 ENG	#1 ENG N1 CONT	Caution Light	#1 eng N1 control loop energized, or Quadrant Microswitches Discrete eng cond lever is not on stop, ground, or flight	Quadrant Microswitches	Discrete
#2 ENG	#2 ENG N1 CONT	Caution Light	#2 eng N1 control loop energized, or Quadrant Microswitches eng cond lever is not on stop, ground, or flight	Quadrant Microswitches	Discrete
CARGO HOOK	CARGO HOOK OPEN	Caution Light	Cargo hook is open	Microswitch	Discrete
PARKING BRAKE	PARK BRAKE ON	Caution Light	Parking brake is on	Microswitch	Discrete
HEATER	HEATER HOT	Caution Light	Temperature within heater exceeds 3500F	Temp Controller Relay Switch	Discrete
LANDING GEAR	MHEEL DE-PHASED	Caution Light	Aft right landing gear exceeds $58^{\rm O}$ LT Phase Switch or $82^{\rm O}$ RT	Phase Switch	Discrete
AC EXT PWR	AC EXT PUR ON	Caution Light	AC external power connected, in use	Relay	Discrete
DC EXT PWR	DC EXT PWR ON	Caution Light	DC external power connected, in use	Relay	Discrete
#1 ENG	(ENGINE FIRE)	Control Handle Warn. Lt. Fire in engine #1	Fire in engine #1	Electrical Network	Discrete
#2 ENG	(ENGINE FIRE)	Control Handle Warn. Lt. Fire in engine #2	Fire in engine #2	Electrical Network	Discrete

TABLE 5. OH-58C PARAMETERS DISPLAYED VIA ANALOG INSTRUMENTS.

SUBSYSTEM	PARAMETER	RANGE	NORMAL OF BAND	HORMAL OP BAND PRECAUTION LIMITS	MALFUNCTION LIMITS	INDICATOR	INDICATOR SIGNAL SOURCE	PARAMETER TYPE
FUEL	FUE! QUANTITY	0-600 LBS.	65-600 LBS.	BELOW 65 LBS.	1	DIAL	UPPER/LOWER TRANSMITTERS ANALOG	ANALOG
GAS PRODUCER	* 9	0-106%	62-105%	,	ABOVE 105%	DIAL	TACH GENERATOR	FREQUENCY
MAIN ROTOR	a a	0-120K	93-110%	,	BELOM 93/ABOVE 110%	DIAL	TACH GENERATOR	FREQUENCY
POWER TURBINE	Š	0-120%	98-100%	,	ABOVE 100%	DIAL	TACH GENERATOR	FREQUENCY
ENGINE	TORQUE	0-120%	0-85%	85-100% A	ABOVE 100%	DIAL	PRESS SENSING PORT	ANALOG
ENGINE	ENG OIL PRESS	0-150PSI	110-130PSI	50-110PSI B	BELOW 50/ABOVE 130PSI	DIAL	DIR.READ, WET LINE PRESS SENS.	ANAL 06
ENGINE	ENG OIL TEMP	-50 -150°C	60-107°C	1	ABOVE 107°C	DIAL	ELEC. RESIST. THERMOCOUPLE ANALOG	ANALOG
XMSM	XMSN OIL PRESS	0-100 PSI	30-60 PSI	60-70 PSI B	BELOM 30/ABOVE 70 PSI	DIAL	PRESSURE TRANSDUCER	ANALOG
ENGINE	101	ე-1000 <mark>-</mark>	300-738°C	738-810°c A	ABOVE 810°C	DIAL	THERMOCOUPLE PROBE	ANALOG
DC PONER	APPETER	0-150 AMPS	0-140 AMPS	•	ABOVE 140 AMPS	DIAL	DC OUTPUT	AVALOG

TABLE 6. OH-58C PARAMETERS DISPLAYED VIA WARNING/CAUTION LIGHTS.

SUBSYSTEM	PARAMETER INDICATION	INDICATOR	EXPLANATION	SIGNAL SOURCE	PARAMETER TYPE
CAUTION	MASTER CAUTION	MASTER CAUTION LIGHT	MASTER CAUTION LIGHT ADVISES THAT CAUTION LIGHT IS ILLUMINATED	CAUTION PANEL	DISCRETE
ENGINE	ENGINE OUT	WARNING LIGHT/TONE	N _G IS LESS THAN 55 ± 3%	TACH PULSE SENSOR	DISCRETE
MAIN ROTOR	ROTOR RPM	MARNING LIGHT/TONE	MAIN ROTOR RPM BELOM 95 ± 1.4%	TACH PULSE SENSOR	DISCRETE
XMSN	XMSN 01L PRESS	WARNING LIGHT	XMSN OIL PRESSURE BELOM 30 PSI	PRESSURE SWITCH	DISCRETE
MSMX	XMSN 01L HOT	WARNING LIGHT	XMSN OIL TEMPERATURE EXCEEDS 110°C	TEMPERATURE SENSOR	DISCRETE
FUEL	FUEL BOOST	CAUTION LIGHT	FUEL BOOST PRESSURE BELOW OPERATING LIMITS	PRESSURE SHITCH	DISCRETE
FUEL	20 MIN FUEL	CAUTION LIGHT	LESS THAN 65 LBS FUEL REMAINING	LOW LEVEL SWITCH	DISCRETE
FUEL	FUEL FILTER	CAUTION LIGHT	FUEL FILTER PARTIALLY OBSTRUCTED	PRESSURE SWITCH	DISCRETE
ENGINE .	ENG OIL BYPASS	CAUTION LIGHT	OIL TANK LEVEL MORE THAN 3 PINTS LOW	LOW LEVEL SWITCH	DISCRETE
ENGINE	ENG CHIP DET	CAUTION LIGHT	METAL PARTICLES DETECTED IN ENGINE	MAGNETIC CHIP DETECTOR	DISCRETE
XMSM	XMSN CHITP DET	CAUTION LIGHT	METAL PARTICLES DETECTED IN XMSN	ELECTRICAL CHIP DETECTOR	DISCRETE
TAIL ROTOR	T/R CHIP OET	CAUTION LIGHT	METAL PARTICLES DETECTED IN TAIL ROTOR GEARBOX	ELECTRICAL CHIP DETECTOR	DISCRETE
AC INVERTER	INST INVERTER	CAUTION LIGHT	NO OUTPUT FROM AC INVERTER	AC FAIL RELAY	DISCRETE
DC GENERATOR	DC GENERATOR	CAUTION LIGHT	NO OUTPUT FROM DC GENERATOR	GEN FATL RELAY	DISCRETE
HYDRAUL IC	HYD PRESS	CAUTION LIGHT	HYDRAULIC PRESSURE BELOW NORMAL	PRESSURE SWITCH	DISCRETE
IFF	155	CAUTION LIGHT	IFF SYSTEM IMOPERATIVE	IFF PANEL SYSTEMS	DISCRETE

TABLE 7. AH-1G PARAMETERS DISPLAYED VIA ANALOG INSTRUMENTS.

						.0T INER IH	TO. NNER HI		
SUBSYSTEM	SUBSYSTEM PARAMETER	RANGE	NORMAL OF BAND	PRECAITTON 1. IMITS	NORMAL OF BAND PRECAUTION LIMITS MALFUNCTION LIMITS	INDICATOR	II Nua roa	STGNAL SOURCE	PARAMETER TYPE
FUEL	FUEL QUANTITY	0-1700LBS.	170-1700 LBS	0-170 LBS	•	DIAL	×	CAPACITATIVE TRANSMITTER ANALOG	ANALOG
FUEL	FUEL PRESSURE	0-50 PSI	5-30 PSI	1	BELOW 5/ABOVE 30 PSI	DIAL	×	PRESSURE TRANSMITTER	ANALOG
ENGINE	ENG OIL PRESS	0-100 PSI	80-100 PSI	1	BELOW 25/ABOVE 100 PSI	DIAL	×	PRESSURE TRANSMITTER	ANALOG
ENGINE	ENG OIL TEMP	-70 -150 ⁰ c 0-93 ⁰ c	0-93 ₀ c	ı	ABOVE 93°C	DIAL	×	ELEC. RES. THERMOCOUPLE	ANALOG
XMSN	XMSN 011 PRESS	S 0-100 PSI	40-60 PSI	ı	BELOW 30/ABOVE 70 PSI	DIAL	×	PRESSURE TRANSMITTER	ANALOG
XMSM	XMSN OIL TEMP	-70 -150°C 0-110°C	0-110°C	•	ABOVE 110°C	DIAL	×	ELEC. RES. THERMOBULB	ANALOG
MAIN ROTOR	z ^x	0-360 RPM	294-324 RPM		ABOVE 339 RPM	DIAL	×	TACH GENERATOR	FREQUENCY
ENGINE	괊	0-7200 RPM	6400-6600 RPM	6000-6400 RPM	ABOVE 6600 RPM	DIAL	×	TACH GENERATOR	FREQUENCY
ENGINE	S _C	0-104%	0-101.5%	•	ABOVE 101.5%	DIAL	×	TACH GENERATOR	FREQUENCY
ENGINE	TORQUE.	0-100 PSI	0-50 PSI	1	ABOVE 50 PS1	DIAL	×	SHAFT TRANSMITTER	ANALOG
ENGINE	EGT	ე-1000 <mark>0</mark>	400-610 ⁰ c	610-625°C	ABOVE 625°C	DIAL	×	BAYONET THERMOCOUPLE	ANALOG
DC POWER DC POWER	DC POWER	•	•	•	•	DIAL	×	VOLTMETER/AMETER	ANALOG

TABLE 8. AH-1G PARAMETERS DISPLAYED VIA WARNING/CAUTION LIGHTS.

CAUTION MASTER CAUTION MA MAIN ROTOR ROTOR RPH WA ENGINE ENG OIL PRESS CA ENGINE ENGINE INLET AIR CA ENGINE ENG OIL BYPASS CA FUEL FUEL BOOST CA FUEL FUEL PUMP CA FUEL 10% FUEL CA FUEL FUEL FILICR CA FUEL FUEL FILICR CA FUEL FUEL FILICR CA KWSN GOV ENER CA XMSN XMSN OIL HOT CA XMSN XMSN OIL HOT CA HYDRAULIC HYD PRESS #2 CA AC INV INST INVERTER CA	WASTER CAUTION WARNING LIGHT/TONE CAUTION LIGHT CAUTION LIGHT X CAUTION LIGHT X CAUTION LIGHT X CAUTION LIGHT X CAUTION LIGHT	***	ADVISES THAT CAUTION LIGHT IS ILLUMINATED ROTOR RPM BELOM 295 OR ABOVE 305 RPM ENGINE OIL PRESSURE BELOM 25 PSI NEGATIVE AIR PRESSURE IN ENG INDUCTION SYS. OIL LEVEL DOWN 3.8 QTS. FROM FULL FWD FUEL BOOST PUMP PRESSURE BELOM 5 PSI AFT FUEL BOOST PUMP PRESSURE BELOM 5 PSI	CAUTION PANEL ROTOR TACHOMETER LON PRESSURE SMITCH NEGATIVE PRESSURE SMITCH LON LEVEL SMITCH PRESSURE SMITCH	DISCRETE DISCRETE
ENG OIL PRESS ENGINE INLET AIR ENG OIL BYPASS FWD FUEL BOOST AFT FUEL BOOST FUEL PUMP 10% FUEL FUEL FILTER GOV EWER XMSN OIL BYPASS XMSN OIL PRESS XMSN OIL HOT IC HYD PRESS #2 IC HYD PRESS #2	/TONE	××× × ×	ENGINE OIL PRESSURE BELOW 25 PSI NEGATIVE AIR PRESSURE IN ENG INDUCTION SYS. OIL LEVEL DOWN 3.8 QTS. FROM FULL FWD FUEL BOOST PUMP PRESSURE BELOW 5 PSI AFT FUEL BOOST PUMP PRESSURE BELOW 5 PSI	ROTOR TACHOMETER LOW PRESSURE SMITCH MEGATIVE PRESSURE SMITCH LOW LEVEL SMITCH PRESSURE SMITCH	DISCRETE
ENG OIL PRESS ENGINE INLET AIR ENG OIL BYPASS FWD FUEL BOOST AFT FUEL BOOST FUEL PUMP 10% FUEL FUEL FILTER GOV EMER XMSN OIL BYPASS XMSN OIL BYPASS XMSN OIL HOT IC HYD PRESS #1 IC HYD PRESS #2 INST INVERTER		×× × ×	ENGINE OIL PRESSURE BELON 25 PSI NEGATIVE AIR PRESSURE IN ENG INDUCTION SYS. OIL LEVEL DOWN 3.8 QTS. FROM FULL FWD FUEL BOOST PUMP PRESSURE BELOW 5 PSI AFT FUEL BOOST PUMP PRESSURE BELOW 5 PSI	LON PRESSURE SWITCH NEGATIVE PRESSURE SWITCH LON LEVEL SWITCH PRESSURE SWITCH	DISCRETE
ENGINE INLET AIR ENG OIL BYPASS FWD FUEL BOOST AFT FUEL BOOST 10% FUEL FUEL FILTER GOV EWER XMSN OIL BYPASS XMSN OIL PRESS XMSN OIL HOT IC HYD PRESS #2 IC HYD PRESS #2		× × ×	NEGATIVE AIR PRESSURE IN ENG INDUCTION SYS. OIL LEVEL DOWN 3.8 QTS. FROM FULL FWD FUEL BOOST PUMP PRESSURE BELOW 5 PSI AFT FUEL BOOST PUMP PRESSURE BELOW 5 PSI	MEGATIVE PRESSURE SWITCH LOW LEVEL SWITCH PRESSURE SWITCH	
ENG OIL BYPASS FWD FUEL BOOST AFT FUEL BOOST FUEL PUMP 10% FUEL FUEL FILTER GOV EMER XMSN OIL BYPASS XMSN OIL PRESS XMSN OIL HOT IC HYD PRESS #2 IC HYD PRESS #2		× ,	OIL LEVEL DOWN 3.8 QTS. FROM FULL FWD FUEL BOOST PUMP PRESSURE BELOW 5 PSI AFT FUEL BOOST PUMP PRESSURE BELOW 5 PSI	LON LEVEL SWITCH PRESSURE SWITCH	DISCRETE
FWD FUEL BOOST AFT FUEL BOOST FUEL PUMP 10% FUEL FUEL FILTER GOV GOV EMER XMSN 01L BYPASS XMSN 01L PRESS XMSN 01L HOT AULIC HYD PRESS #1 WLLC HYD PRESS #2		× >	FWD FUEL BOOST PUMP PRESSURE BELOM 5 PSI AFT FUEL BOOST PUMP PRESSURE BELOM 5 PSI	PRESSURE SWITCH	DISCRETE
AFT FUEL BOOST FUEL PUMP 10% FUEL FUEL FILTER GOV GOV EMER XMSN OIL BYPASS XMSN OIL PRESS XMSN OIL HOT AULIC HYD PRESS #1 4ULIC HYD PRESS #2		× >	AFT FUEL BOOST PUMP PRESSURE BELOW 5 PSI		DISCRETE
FUEL PUMP 10% FUEL FUEL FILTER OV GOV EWER XMEN 01L BYPASS XMSN 01L PRESS XMSN 01L HOT ULIC HYD PRESS #2 V INST INVERTER	TION LIGHT	× ,		PRESSURE SWITCH	DISCRETE
FUEL FILTER OV GOV EWER XMSN OIL BYPASS XMSN OIL PRESS XMSN OIL HOT ULIC HYD PRESS #2 V INST INVERTER	1001	>	FUEL PUMP PRODUCING LOW PRESSURE	PRESSURE SMITCH	DISCRETE
FUEL FILTER OV GOV EMER XMEN DIL BYPASS XMEN DIL PRESS XMEN DIL HOT ULIC HYD PRESS #2 V. INST INVERTER	CAULIUM LIEM	<	LESS THAN 10% (17 LBS) FUEL REMAINING	LOW LEVEL SWITCH	DISCRETE
XMSN OIL BYPASS XMSN OIL PRESS XMSN OIL HOT ULIC HYD PRESS #2 V INST INVERTER	CAUTION LIGHT	×	FUEL FILTER PARTIALLY OBSTRUCTED	PRESSURE SWITCH	DISCRETE
XMSN OIL BYPASS XMSN OIL PRESS XMSN OIL HOT ULIC HYD PRESS #1 ULIC HYD PRESS #2 V INST INVERTER	CAUTION LIGHT	×	GOVERNOR SMITCH IN EMERGENCY POSITION	PANEL SWITCH	DISCRETE
XWSN OIL PRESS XWSN OIL HOT ULIC HYD PRESS #1 ULIC HYD PRESS #2 V INST INVERTER	CAUTION LIGHT X		XMSN OIL BYPASSING COOLER, PRESS BELOM 30PSI	LOW LEVEL SWITCH/PRESS SW.	DISCRETE
WEST OIL HOT ULIC HYD PRESS #1 ULIC HYD PRESS #2 V INST INVERTER	CAUTION LIGHT	×	XMSN OIL PRESSURE BELON 30 PSI	PRESSURE SMITCH	DISCRETE
~	CAUTION LIGHT	×	XMSN OIL TEMP AT OR ABOVE 110°C	THERMOSMITCH	DISCRETE
~	CAUTION LIGHT	×	SYSTEM 1 HYDRAULIC PRESSURE LOW	PRESSURE SWITCH	DISCRETE
INST INVERTER	CAUTION LIGHT	×	SYSTEM 2 HYDRAULIC PRESSURE LOW	PRESSURE SWITCH	DISCRETE
	CAUTION LIGHT X		NO AC POWER OUTPUT	AC FAIL RELAY	DISCRETE
DC GEN DC GENERATOR CAN	CAUTION LIGHT	×	NO DC POWER OUTPUT	DC GEN FAIL RELAY	DISCRETE
EXT PUR EXTERNAL POWER CAL	CAUTION LIGHT X		EXTERNAL POWER CONNECTED	EXT PWR RELAY	DISCRETE
XMSN XMSN CHIP DET CAL	CAUTION LIGHT	×	X METAL PARTICLES IN MAIN XMSN	MAGNETIC CHIP DETECTOR	DISCRETE

TABLE 8. CONTINUED.

			ורסע	OTH COTH	NOT TAKE AND THE	SIGNAL SOURCE	PARAMETER TYPE
SUBSYSTEP	SUBSYSTEM PARAMETER INDICATION INDICATOR	ION INDICATOR	d	8	LAT LANGE SECTION AND ADDRESS OF THE PARTY O		
NJEN	A20 CHIB DET	CAUTION LIGHT		×	X METAL PARTICLES IN 42° GEARBOX	MAGNETIC CHIP DETECTOR	DISCRETE
WO W	7	TOT I TOTAL		×	METAL PARTICLES IN 90° GEARBOX	MAGNETIC CHIP DETECTOR	DISCRETE
N S	96° CHIP DEI			•		Mecurity Cuts octention	DISCRETE
ENGINE	ENG CHIP DET	CAUTION LIGHT		×	METAL PARTICLES IN ENGINE	MUMEITO CHIL DELECTOR	
166	175	CAUTION LIGHT	×		IFF SYSTEM INOPERATIVE	IFF SYSTEM NETWORK	DISCRETE

TABLE 9. PARAMETERS DISPLAYED IN FOUR HELICOPTERS.

Parameter	<u>Indicator</u>
Fuel Quantity	Ī
Engine Oil Temperature	1
Engine Oil Pressure	I
N _G	I
XMSN Oil Pressure	I
N _R _	I
% ^K Torque	I
Fuel Low	С
Engine Chip	С
XMSN 0il Pressure Low	C/W
XMSN Oil Temperature High	C/W
Chip Main XMSN	С
Generator Output Low	С
Master Caution	M

^{*} I: analog instruments; C: caution light; W: warning light; M: master caution light.

TABLE 10. PARAMETERS DISPLAYED IN THREE HELICOPTERS.

<u>Parameter</u>	Indicator *	Exception
DC Load Meter IFF Incoperative PRI Servo Press Fuel Filter Bypass Oil Filter Bypass Np Chip Tail XMSN Low Rotor RPM Fuel Press Low XMSN Oil Pump	I C C C I C W/T C	UH-60A CH-47C CH-47C CH-47C CH-47C CH-47C CH-47C CH-47C OH-58C

^{*} I: analog instruments; C: caution light W: warning light; T: audio tone

TABLE 11. PARAMETERS DISPLAYED IN TWO HELICOPTERS.

Parameter	Indicator *	Helicopters Dis	playing Parameter
Engine Fire	W/C	UH-60A	CH-47C
Boost Servo Press Low	c'	UH-60A	CH-47C
Ext PWR Connected	A/C	UH-60A	CH-47C
SAS Off	C	UH-60A	CH-47C
Cargo Hook Open	A/C	UH-60A	CH-47C
Parking Brake On	A/C	UH-60A	CH-47C
APU Overspeed	C	UH-60A	CH-47C
APU Exhaust Pump Hi	Č	UH-60A	CH-47C
APU Oil Press Low	Č	UH~60A	CH-47C
Eng Oil Press Low	Č	UH-60A	AH-1G
Chip Int XMSN	Č	UH-60A	AH-1G
Rotor Overspeed	Č	UH-60A	AH-1G
Engine Out	W	UH-60A	0H-58C
Fuel Boost Press Low	Ĉ	0H-58C	AH-1G
AC Inv Output Low	Č	0H-58C	AH-1G

^{*} W: warning light; C: caution light; A: advisory light.

TABLE 12. PARAMETERS DISPLAYED IN ONE HELICOPTER.

Parameter	Indicator *	Helicopter Displaying Parameter
Prime Boost Bump On	Α	UH-60A
Eng Oil Temp Hi	Ċ	UH-60A
•		
Hyd. Pump Press	Č	UH-60A
Pri Servo Jam	Ç	UH-60A
Boost Servo Jam	C C	UH-60A
T/R Servo Press	Ç	UH-60A
Backup Pump On	A	UH-60A
APU Fire	M	UH-60A
Stabilator Pos	I C	UH-60A
APU Underspeed	Č	UH-60A
APU Sequence Fail	C A	UH-60A
APU GEN On		UH-60A
APU On	A	UH-60A
Converter Output Low	C	UH-60A
Batt Low Charge	C	UH-60A
Batt Fault	Ç	UH-60A
AC ESS Bus Off	C	UH-60A
DC ESS Bus Off	A C C C C C C	UH-60A
Fit Path Stab Fail	L C (T	UH-60A
Stab Auto In OP	C/T	UH-60A
Pitch Bias Fail		UH-60A
Gust Lock Not Disengaged	C C A A	UH-60A
Anti-Ice On	A	UH-60A
Pitot Heat On	Ä	UH~60A
Cargo Hook Armed	Ä	UH~60A UH~60A
Eng Start Valve Open Fuel Pressure	L 1	0H~60A AH~1G
Inlet Air Press Neg	Ç	AH-1G
	C	CH-47C
Eng Oil Quantity Low N1 Control Loop Energize	od C	CH-476
Fit Ctrl Hyd Press	tu C	CH-47C
Utility Hyd Press	7	CH-47C
Rectifier Off	r L	CH-47C
AC Load Meter	ť	CH-47C
Heater Hot	Ċ	CH-47C
Wheel De-Phased	r	CH-47C
APU Tach	C C C C I I C I C	CH-47C
711 0 14011	•	011-47 0

^{*}I: analog instruments; W: warning light; C: caution light; A: advisory light; T: audio tone.

TABLE 13. UH-60A INFORMATION REQUIREMENTS.

PARAMETER	PRIORITIES	MISSION PHASE	ENVIRONMENT	DISPLAY	FORMAT	NE- PONSE	FEE
	MESTON MESTON MATERIALS UNICESSAN	TAKEDFF CRUTSE HOVEN LAND SAUTSONN	AI GHT DAY VNC 11VC H DE AL TITUS	CONTINUAL CONTICUL DRY ACCESS ONLY	QUALITATIVE QUALITATIVE CORTINED CORTINED ADVISORY	AUTO DESTRABLE AUTO NOT <u>BESTRABLE</u>	DISPLAY UNECESSARY
Fuel Quantity	x						•
Fuel Law	x				x		īΤ
Fuel Pressure	×			1141	TXIII		ī
Fuel Pressure Low						111	!
Fuel filter Obstructed				$\Pi\Pi$		1	,
Prime Boost Pump On	X			TAT	TITT		I
Fuel Boost Pressure Low		1.1111		$\Pi\Pi$			iΤ
	71111			\prod		$\Pi \Gamma$	П
•							П
Engine 011 Temperature				1,111			П
Engine 011 Temperature High							Π
Engine Oil Pressure				1,111			П
Engine 01) Pressure Law				T , I i	×		Π
Engine 01) Quantity					$\Pi\Pi\Pi$		П
Engine Oil Quantity Low							
Oil Filter Bypass	x			$\prod_{\mathbf{k}} \prod$			\prod
Engine Chip	×						Π
							П
							П

TABLE 13. CONTINUED.

PARAMETER	PRIORITIES	MISSION PHASE	ENV I ROMMENT	DI SPLAY	FORMAT	DE- FEED- POISE BACK
	SAPETY MESSION PALIFFERNIC UMEGGSSARY	TAKEOF CRUTSE HAVER LANC SKUTDOM	MI GHT DAY DAY INC MOE ALTITUDE	CONTINUAL CRITICAL ORLY ACCESS ONLY	GUALTTATIVE COULTTATIVE COUSINED CULTION ADVISORY	AUTO DESTRACE.
III	×			x	l k	
tel						$\Pi \Pi$
*,	×			×	×	
inlet Air Pressure Negative						
						l i
Ng	×	1		x	×	
Engine Out	x			l × l	×	
N ₁ Control Loop Energized						
					_11111	
MMSN 011 Pressure	×					
XMSN OIT Pressure Low	×			k	×	
MMSN 011 Temperature	×					
MMSN OIL Temperature High	×					
Chip Main XMSN	<u> x </u> _		_[×	
Chip Int XMSN	x					
Chip Tail XMSH	x					
AMON OIL Bypass	x					
	1111	11111	111111	1111	11:11	

TABLE 13. CONTINUED.

PARAMEYER	P	8)(JĄ I	11	ES	M	ISS	10	M (MU	SE	:	EI	W)	NO		NT			DI:	SPL	.AY		f	04	M	ı	•	;	E-	SÆ	 1	EEI)- K
	CAPTRA	2000	WATHTENANT	UNINECESSARY			TACOFF	26.35		Contract of the Contract of th			27050	ia	T. C.	¥	Ž	ALTITUDE.		CONTINUAL	CRITICAL DREY	ACCESS ONLY		CHARTTARTY	OUR TEXTIVE	COMPANY	PETER .	Jac: 50		AUTO DESTANGLE	ALTO THE PERSON	NI CEN IV	DISPLAY LIMITERSON	
",	k	l	I				1		Ī	1	1									×				k	I		L					i	I	L
Main Rotor Overspeed	k	T	1	П		7	T	1	T	T	T		T								×	П				7		П				T	Ţ	Γ
tow Rotor RPM	k	I					I	I	I	I			I								X			Γ	I	ŀ				X		i	K	Γ
	I		L					1	1						L					L				l	L	L	L					Ī	1	I
										1			1							L	Ц	į				L	L	Ц	1					l
* Torque	k	L	L	Ц		1			1	1					L					X	Ц			L	L	×		Ц		1		1	L	L
				Ц		1			1				L	L						L	Ц							Ц				ĺ	L	
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Primary Serva Pressure Law	k					1					L		L	L							×						×	Ц				 floor	Ţ	
Hydraulic Pump Pressure Low	k	L	L			1	1							L	L		}				×				L		x		Ц			1	1	
Primery Servo Jam	k																				×						×	Ц			3	I	m I	
Boost Servo Jam	k	L					1	1	1				L								x						x							
Boost Serva Pressure Low		k					1	1	1]			L	L							x				Ŀ		×							
Tell Rutur Serva Pressure tow		k				1	1		1	1			L	L	L	Ц			· 		×						Ł	Ц			1	 1	L	
Backup Pump On	L	×	L	Ц					1]_	L		Ц	1				×				Ĺ	L		ĸ				 1		
Flight Control Hydraulic Pressure	×	L							1					L		Ц					X		_	L		L	×						L	
Utility Hydraulic Pressure	<u> </u> x										1			L							×						k							L
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TABLE 13. CONTINUED.

PARMIETEN	PRIORITIES	MISSION PHASE	ENVIRONMENT	DI SPL AY	FORMAT POR:	IE BACK
	SAPETY INTEGRALI INMEGESSARY	TACEOF CAUSE CAUSE LANC SAUTION	BIGHT DAY THE THE NOT ALTITUS	CONTINUAL CRITICAL OWY ACCESS ONLY	QUARTITATIVE COUNTIATIVE COMBINED CAUTION ADVISORY AUTO DESTRABLE	DISPLAY UNICESSAN
APU Exhaust Temperature High						1-11-
APU 011 Pressure Low	x					ix
APU Overspeed) x			1	<u> </u>	<u> × </u>
APU Underspeed	x			121		1 ix 1
APU Sequence Fail	x	_!!!!!			▗ ▋▍▋ <mark>┡</mark> ╏╏┆╵	× ×
APU fire	×	_!		1 1	111214	x
APU Generator On	k			1 1	-1111611	1111
APU On				111		
'APU Tachameter			_1111111			1-44
				4111		
				-1111-		
Generator Output	X					
AC Inverter Output Low				-1111	-111111	
Converter Output tow	x				1111411	_
Rectifier Off				-1111		
Battery Low Charge						$H \rightarrow H \rightarrow$
battery fault	×	<u> </u>			_ <u> </u>	-
AC LSS Bus Off	<u>k </u>		_		<u> </u>	H-H
M Fss Bus Off	k			k		11111

TABLE 13. CONTINUED.

PARAMETER	PRIORITIES	MISSION PHASE	ENV I AGNOVENT	DISPLAY	FORMAT POI	FEED-
	AAFTY HISTOR FAINTENANCE UMMEGESSARY	TAKEDF CHUISE HOYER LAND SAUTDON	MISHT DAY PHC 1906 ALTTTUE	CONTINUAL CRITICAL DRLY ACCESS ONLY	11/4/1/4 1/4/1/4 99 99 99 99 99 99 99 99 99 99 99 99 99	AUTO NOT DESTRACT. DISPLAY UNICESSUAY
AC Load Meter						
DC Load Meter				Ш		
				1111		
				<u> </u>	<u> </u>	
Engine fire	×		<u> </u>		x !	!!!!!
Flt Path Stab Sys Fail	x	<u> </u>		<u> </u>		
Stabilator Auto Mode In Op	×				<u> </u>	
Stabilator Position	x				x x	x
				1111		
SAS Off	×				M	
· · · · · · · · · · · · · · · · · · ·						
Pitch Bias Failure	X				x	
			_		<u> </u>	
			_	<u> </u>		-
Gust tock Not Disengaged						
		_		+HH		H []

TABLE 13. CONTINUED.

PARMETER	PRIORITIES	MESSION PHASE	ENVIRONMENT	BISPLAY	FORMAT PONS	FEED-
	54,777 14,157,194,44 14,157,194,44 14,157,194,44 14,177,194,44	TAKOFF CRUSS CRUSS CRUSS CANCE SAUTORN	MIGHT DAY DAY SWE SWE ANTITUDE	CONTINUAL CRITICAL ORLY ACCESS ORLY	OUNTITATIVE COULTATIVE COULTATIVE CAUTION ADVISOR	DISPLAT UNICESSARY
Eng. Anti-Ice On	×			7	TIMIT	1111
				7111	11111111	Till
						i
Pitot Heat On	×			k		1
				1111	1111111	
Heater On						
lketer list				1111	1111111	
				1111	1111111	
				$\perp \downarrow \downarrow \downarrow \downarrow$		
Cargo Hook Open	X	_11111_				
Cargo Hook Armed	X			141	1111×111	
						1-111-
				444	<u> </u>	
Parking Brake On				1	<u> </u>	$\perp \downarrow \downarrow \downarrow$
			-144444	4444		1-111-
				1111		
Eng. Start Valve Open				X	1111×11	
Master Caution	x					1 111

TABLE 14. CH-47C INFORMATION REQUIREMENTS.

PARMETER	PRIORITIES	NISSION PHASE	ENV I ROOMENT	BISPLAY	FORMAT	RE- PONSE	FEED-
	SAFETY FISSION PAINTENANCE UNINECESSARY	TAKEDFF CRUISE LAVER LAVE SIUTIONN	BIGHT PRIVE INC NOE ALTITUE	CONTTRUAL CRITICAL DRLY ACCESS DRLY	QUANTITATIVE QUALITATIVE CONSINED CAUTION	AUTO DESTRABLE AUTO NOT DESTRABLE	DISPLAY DISPLAY UNNECESSARY
Fuel Quantity	×			×	×		1
fuel Law	x				×		\prod
fuel Pressure	x			k	×		
fuel Pressure Low	Х			X	MIII		
Fuel filter Obstructed							<u> </u>
Prime Buost Pump Un							
fuel Boost Pressure Low							Ш
							Ш
							\prod
Englie Oll Temperature	×				x		Ш
Engine Oll Temperature High	X	_		1 4 1 1	×		Π
Engine Oil Pressure	×				×	$\Pi\Pi$	\prod
Engine Oil Pressure Low	x			k i	x .		\prod
Engine Oil Quantity						Ш	Π
Engine Oil Quantity Low							
Oil filter Bypass							\prod
Engine Chip	×			×			Π

TABLE 14. CONTINUED.

PARAMETER	PRIORITIES	MISSION PHASE	ENVERONMENT D	ISPLAY	FORMAT	RE- FE PONSE BA	ACK ACK
	SAPETY MISSION MAINTENANCE UNINECESSARY	TACOFF CALISE LAVE LAVE SAUTOGRA	NISHT DAY WE WE INC NISTORY	CRITICAL ONLY ACCESS ORLY	QUANTITATIVE QUALITATIVE COMBINED CAUTION ADVISORY	AUTO DESTRABLE AUTO NOT DESTRABLE DISPLAY	DISPLAY UNNECESSARY
TII						111	Γ
EGI	×			x	A		Γ
N _p							Γ
Inlet Air Pressure Negative						11 :	
						11 :	L
		!}}}					ļ
N _g	X		1111111	IX I	IX		L
Engine Out							
N, Control Loop Energized	×			x] ×		1
	_[]]]]		1111111	111			l
MISH OIT Pressure	×			×	×		
IMSN Off Pressure Low	x			×	×		
MMSN 011 Temperature	×			×	x		
MMSN Oil Temperature High	×			x]x		
Chip Mein XMSN				JX .	X		
Chip Int XMSN			_ <u> </u>				
Chip Tail XMSH				111_		1444-4	
AMON OLI Bypass]]_]_].	-
	11111	11111	_1111111.1				

TABLE 14. CONTINUED.

PARAMETER	PI	110	Rį	T + 4	S	HI	SS	10	N I	PIV	121	E	EN	۷I	RO	194	E M.	r_		DI:	SPI	LAY		F	00	MAT	!		P	OH E-	SE		FE	TEI NCI
	CLEATY	MISSION	MAINTENANCE	UNIVECESSARY			TAKEOFF	CRUISE	Name of the last o	Contract of the second of the	Shu i Lown		KIGHT	Pav		100	3ON	ALTITUDE.		CONTINUE	CRITICAL DAILY	ACCESS ONLY		Children a Prove	MIN TATTVE	COMPLET	CAUTION	ADVISORY		AUTHO DESTRABLE	AUTO NOT DESTRABLE		DISPLAY	DISPLAY UNINECESSARY
M _R	×	1					1		1	1	1		L	L	L	L	L			×	Ł				l	×		Ц			Ц		1	L
Main Notor Overspeed	T						1		1	1	_{									Ĺ	×				l	×		U					<u> </u>	
Low Rotor RPM	T					1	1	1	1	T	J		Γ	Γ	T	Γ	Γ	П		Γ	×				Ţ	k	П		I				i	
	T					T	1	J	J	Ţ	J			ſ	T	Γ	Γ			Γ	Γ				Ţ				Ì				!	
	T	Γ	П			1	T	Ī	1	Ţ	Ţ		Γ	Γ	T	Γ	Ī	П		Γ	Γ	Γ		I	T	Γ	П		I				·	
1 lorque	T _x	T				Ī	1	1	Ţ	T	T		Γ	Γ	T	Γ	Γ			X	T	Ţ	•	1	Ţ	×		П	Į				T	Ţ
	T	T				Ī	1	1	1	T	1		Γ	Ī	T	T	Ī		Г	Ī	T	T	<u> </u>	T	T	Γ		П	П		П		T	Ī
	T			П		1	1	1	Ī	1	7		T	T	T	T	T		Г	T	T	T	1	T	T	Γ	П		П	П	П		T	Ī
Primary Servo Pressure Low	T	T		П		7	7	1	1	T	1	·	T	T	T	T	T			T	T	T		T	T	Γ	П		П		П		T	Ī
Hydraulic Pump Pressure Low	Ī	×	П	П		1	1	1	1	1	1		Ī	Ī	T	T	Ī			T	k	T	Ī	T	T	Γ	k		П		П		T	Ī
Primary Servo Jam	T	T		1		1	1	1	1	7	1		T	t	1	1	T		Γ	T	T	T	Γ	T	T	T			П	П	П		T	Ī
Boost Servo Jam	T	T				1	1	1	1	7	1		ľ	Ī	1	T	T	Γ	Γ	T	T	T	Ī	T	T	Γ	Г		П	Π	П		T	Ī
Boost Servo Pressure Low	T	T				1	1	1	1	1			T	Ì	1	1	T	T	Γ	T	ľ	T		T	T	T			П	П	П		T	Ī
Tall Rotor Servo Pressure Low	T	1				1	1		1	7	1		T	Ī	1	T	T	Ī	Γ	T	T	T		T	T	T			П	П	П		T	Ī
Backup Pump On	T	r		П		1	1	1	1	1	1			Ī	1	T	T	T		T	Ī	ſ		T	F	Ī			П	Π	П		T	Ī
Flight Control Hydraulic Pressure	×	T		\prod		1	7	1	1	1	1		T	T	1	T	T	Γ	Γ	T	k	T	Γ	T	T	T	×	Γ	П		П		T	Ţ
Utility Hydraulic Pressure		T				1	1	1	1	1			T	T	1	T	T	T	Γ	1	Ţ	T	Γ	T	T	T	Ţ	Γ	П	Π	П	Γ	T	Ī
	ľ	t	ľ		_	7	1	1	1	7	1		1	t	1	1	t	1		1	ľ	1	†	1	t	T	۲	r	П		П	Γ	†	Ť
	T	-	┢			7	7	1	1	7	1		T	Ì	†	1	Ť	t	Γ	1	1	Ť	1	†	t	T	Γ	T	П	Γ	Ħ		†	Ť
· Julius Bar in the Hambur tour Humbers	+	1	t	-		-	- {	-	1	1	1		1	t	t	t	t	t	-	1	t	1	ļ-	†	1	~-	r		11	П	П	-	7	t

TABLE 14. CONTINUED.

PARAMETER	PRIORITIES	MISSION PHASE	ENYSRONMENT D	ISPLAY FORMAT	DE- F PONSE D	MCK EED
	SAPETY MISSION PKINTENNICE UMMECESSARY	TAKEOFF CRUISE HOYER SKUTDONN	NI GHT DAY DAY DAY THOS HOSE ALTITOS	CRITTAL ONLY ACCESS ONLY ACCESS ONLY OUNTITATIVE COMMITTATIVE COMMITTATIVE COMMITTATIVE COMMITTATIVE COMMITTATIVE COMMITTATIVE COMMITTATION	ADVISORY AUTO DESTRABLE AUTO NOT DESTRABLE	DISPLAY UNKECESSARY
APU Exhaust Temperature High	x			x	x x x x	\prod
APU Q11 Pressure Low				×	x x x	П
APU Overspeed	×			x	, _x _x	\prod
APU Underspeed	, k			x	x lxl x	\coprod
APU Sequence Fall						\prod
APU Fire						\prod
APU Generator On				1		П
APU On						П
'APU Tachometer						\prod
						П
						П
Generator Output	×			x x		П
AC Inverter Output Low						\prod
Converter Bulput Low						\coprod
Rectifier Off	×			x X X		\coprod
Battery Low Charge						Ш
Battery fault						\coprod
AC ESS Bus Off						\prod
DL Ess Bus Off						Ш

West Comment

TABLE 14. CONTINUED.

PARAMETER	PRIORITIES	MISSION PHASE	ENVIRONMENT	DISPLAY	FORMAT	RE - POUSE	FEE
	SAFETY FISSION PAINTENANCE UNNECESSARY	TAKEOFF CRUISE HAVER LAND SHUTDOM	JAI GIT DAY DAY THE HOS A 1 1710E	CONTINUAL CRITICAL ONLY ACCESS ONLY	QUANTITATIVE COMMITTATIVE CONSINED CONSINED CANTION	AUTO DESTRABLE AUTO NOT DESTRABLE	DISPLAY
AC load Heter	×			×	×		-
UC Load Meter	×				×		I
Engine Fire	x			, I			!
FIL Path Stab Sys Fall							
Stabilator Auto Mode In Op		i					П
Stabilator Pusition						Ш	П
							\coprod
				TIII			\prod
SAS Off	x				×		\prod
					ТПП	$\Pi\Pi$	П
							\prod
Pitch Blas Fallure						$\Pi\Pi$	\prod
							\prod
					ШП		\coprod
Gust Lock Not Disengaged						III	\prod
							П
					Ш	Ш	Π

TABLE 14. CONTINUED.

PARAMETER	PRIORITIES	MISSION PWASE	ENVIRONMENT D	ISPLAY FORMAT	RE - POUSE	FEEL
	SAFTY HISSION HAINTENAUL UMNETESSAN	TAZOF CRUTSE HOVER LAND SHOTOGAN	Alleri DAY YWC YWC HOY HOY ALTITUDE	CONTINUE ACESS ORLY DUMITIVATIVE	ADVISORY AUTO DESTRABLE AUTO NOT DESTRABLE	DISPLAY DISPLAY UNNECESSARY
Eng. Anti-Ice On						I
					11111	1
				-	<u> </u>	4
Pitot ilest On				- -	<u> </u>	4
					 : 	
				- 	 	╬
Heater On					╂╁╁╏╂╾	#
Heater Hot	X			<u> </u>	 	#
				┦╏┋╸╏╏╏	{}}}	╫
				╫┼╌┼┼┦	╂╂╂╂╌	₩
Cargo Hook Open	 			 -	 	++
Cargo Hunk Armed			╌╏╏╏╏	╌╂╂┼╌┼╂╂╂	╂╂╂╂┼	₩
151 Ohd			- 	\ <u>\</u>	 	╫
Wheel Dephased Parking Brake On	<u>*</u>	-+ + -	╶┞╏ ┠╋╂╂╌╂		7. -	$+\!\!\!+$
	─┤ Ĭ┤┤		-111111	- * -	 	$\dagger \dagger$
			-	 	 	#
Eng. Start Valve Open		~{}}		- - - - - - - - - - - - - - - - - - - -	╁┼┼┼┼	$\dagger \dagger$
Master Caution	x				 	71

TABLE 15. OH-58C INFORMATION REQUIREMENTS.

PARAMETER	PRIORITIES	MISSION PHASE	ENVINCIPLENT	DISPLAY	FORMAT	DE- FEI PONSE DA	CR ED-
	SAFETY HISSION HAJINTENANC HMIGGESSARY	TAKEOF CRUSSE FOTE LAKO SKATIDOM	MICHO DAY DAY INC ALTITUDE	CONTINUAL CRITICAL DRY ACCESS DREY	OUNTITATIVE QUALITATIVE CORTICO CANTON	AUTO DESTRUBLE AUTO NOT <u>DESTRUBLE</u> DISPLAY	DISPLAY UNICESSARY
fuel Quantity	x			k i	l x		\mathbf{I}
fuel tow	×			1	×		T
fuel Pressure	11111		1111111	1111	11111		T
fuel Pressure Law				1111			T
fuel filter Obstructed	<u>, </u>			1,11			T
Prime Boost Pump On	×			1		:	T
Fuel Boust Pressure Low							T
							T
•					$\Pi\Pi\Pi$		Ι
Engine Oil Temperature	x I I I			THI	$\prod_{k}\prod$		T
Engine Oll Temperature High					T x		T
Engine 01) Pressure	,						T
ingine Oil Pressure low	x				x.		T
Engine Oil Quantity							T
Engine Oil Quantity low							Ι
Oll Filter Bypass	×			×	x		T
Englue Chip	k				×		T
							T
				1771			T
	11111		IIIIII				Ţ

TABLE 15. CONTINUED.

PARAMETER	PRIORITIES	MESSION PHASE	ENVI ROWNENT	DISPLAY	FORMAT	NE- PONSE	FEED-
	MISSION MISSIO	TAKEOFF CRUISE LANOTE SAUTOGRA	KIGHT DAY WE WOE NOE ALTITUSE	CONTINUAL CRITICAL ONLY ACCESS ONLY	QUANTITATIVE QUALITATIVE CONSINED CONSINED ANTERNATION	AUTO NOT DESTRUCT	DISPLAY UNICESSARY
111						1111	\coprod
EGI (TOT)	х			×	×		
N _p	x			×	×		
Inlet Aly Pressure Megative				\coprod			
			1111111	1111	11111		Ш
				1111			Ш
Ng	x			i x I			Ш
Engine Out	x			×	×		Ш
N ₁ Control Loop Energized							Ш
					11111		Ш
							\coprod
XMSN OIT Pressure	x			x	×		Ш
XMSN 011 Pressure Low	x			x	x		\prod
XMSN OIl Temperature	_						
XMSN OII Temperature High	×						\prod
Chip Main XMSN	x				×		Ш
Chip Int XMSN	x				x		Ш
Chip Tail XMSH							\prod
XMSN Oil Bypass							
	11111						

TABLE 15. CONTINUED.

PARAMETER	₽(RIO	WI	11	ES	M	ISS	10	a	Pil	AS(E	EN	VII	LON.	HE	NT	_	1	DIS	PL.	AV		f	00	HA!	<u> </u>		1	NE -	154	<u>. </u>		FE	CK ED-	
	Cherry	MISSION	MAINTENANCE	UNNECESSARY			TAICOFF	CRUISE	HOVER	LAND Fire parties	SMU I DUMA		MISH	DAY	VAC	¥.	100 P	30011		CONTINUAL	באנונה שני	ALLESS GAL!		PRIMITE PRIME	OUR! TATTOR	COMBINED	CASTION	ADV (SORY		AUTO DESTRABLE	AUTO NOT DESTRUELE		- -	DISPLAY	DISPLAY UNIECESSARY	-
".	Į,	1					İ				1					1	1			X				k		L		U			L	L	ì		L	_
Mein Autor Overspand	T	Γ	Γ			1			T	1			Γ			I	1	1			×		_		I	×										
tow Rotor APH	T	Ī				1			Ī	1	1		Γ				T	I			×	1		I	Ī	k					1		i		brack I	_
	T	Γ								I							I											\bigcup			1	L	ļ			_
	T	T		П					J	I							I					i		L							ĺ				m I	_
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	T	T				Ī		7	Ţ	Ţ	T		Γ			Ţ	Ţ	Ţ			Į	i		Ţ	T						ļ				Į	
	1	T				٦		1	Ī	1	Ī		Γ				T	Ţ	ĺ	_		Ī		T	Ī	Γ	П				Γ					
Primary Serve Pressure Low	T	1		П		7	1		1	1	1		Ī				I	I			-	1		I	Ī						Ī					
Hydraulic Pump Pressure Low	×	Ι	Γ	П		1	_[1	I	Ţ	1		Γ			I					×	1		I	ľ	×									\prod	
Primery Servo Jam		I				I											I	I				I		I											I	
Boost Servo Jam	T	T	Ī				1		J	1			Γ				1					Ì			ľ			L			l	L				
Boost Servo Pressure Low	T	T									1						1	I							ŀ						I				\mathbf{I}	
Tail Rotor Servo Pressure Low		Ī						1		1	I		E				1	1				Ì			ľ			Ц			L					
Backup Pump On	Ι	Γ							I													\int			ŀ											
Flight Control Hydraulic Pressure	T	ſ	ſ			1		1			1						\int				1	1		I	ſ											
Utility Hydraulic Pressure	T	Γ				7	7	J	J				Γ				ľ	J				Ţ		T								ŀ				
The same of the sa	1	ľ	٦	[~	-	1	ľ		١					1	1	1			1	1		T	1		П					Γ		П	1	
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	1-	1	٦	۱ ۱		1	-	1	1	1	1		1				1	^	-			Ţ		T	ľ		П	Ī	ļΊ	Γ	T	Γ	_		Ţ	-

TABLE 15. CONTINUED.

PARAMETER	PRIORITIES	MISSION PHASE	ENVIRONMENT	DI SPLAY	FORMAT PONS	
	SAFETY INTSSTOR WAINTENANCE LUMNECESSARY	TAKEDFF CRUISS NOTE NATE SHUTBOAN	KI GAT. DAY DAY THE THE NOT ALTITUDE	CONTTRUM, CRITICAL ORLY ACCESS ONLY	COMMITTATIVE COMBINED COMBINED COMBINED CAVITOR ADVISORY MATTO DESTABLE ANTO DESTABLE	DISPLAY UNICCESSARY
APU Exhaust Temperature High	$\Pi\Pi\Pi_{-}$					
APU GIT Pressure Low						
APU Overspeed				1111	11111111	
APU Underspeed						
APU Sequence Fail					<u> </u>	<u> </u>
APU Fire		111111		1111	11111111	
APU Generator On				1111		
APU On						
'APU Techometer						
	11111				<u> </u>	
Generator Output				×		
AC Inverter Output law						
Converter Output tow				$\perp \parallel \parallel$	<u> </u>	
Nectifier Off						1-111-
Battery Low Charge	<u> </u>			1111		1-111-
Battery Fault						
AC ESS bus Off						1-111-
AC tes Bus Off				_1111		1_11_

TABLE 15. CONTINUED.

PARAMETER	PRIORITIES	MISSION PHASE	ENVIRONMENT	DISPLAY	FORMAT PO	FEED- DISE BACK
	SAPETY TISTION PATERIARE VINECESSARY	TAKEDFF CRUISE LAVE SAUTDON	MIGHT. DAY DAY THE NO.	CONTINUAL CATTICAL DALY ACCESS DALY	QUANTITATIVE QUALITATIVE CORBINED CAUTION ADVISORY	MATO ANT DESIDUALE DISPLAY UNICEESSAN
AC Load Meter		111111	1111111	Ш	ШШ	
DC Load Meter	×			×		
	$\Pi\Pi\Pi$					11 111
			$\neg \Pi \Pi \Pi$		1111111	
Engine Fire				1111		
fit Path Stab Sys Fail		- 11111	-111111	111	 	
Stabilator Auto Mode In Op			-111111	 	111111	
Stabilator Position			-+++++	1111	1111111	++-++-
			╼╂╂╂╂╂╂	++++	+++++	††-++ †-
	╼╁╁╁╁	 - - - -	- 		111111	11-111-
SAS Off	╼┼┼┼┼	─┤╂ ╂╂┼	╼╂╂╂╂╂	╼╊╋╂╂╾	╁╂╂╂╂	╂╌╂╂┼╾
392 011	-++ -		- + 	╌╂╂╂╾	╂╫╫╫	╂╌╂╂╌
	╍┾┼┼├╾	╌┠╏╏╏	╌┠╂╃╂╂		╂╂╂╂╂	╂╌╂╂╾
		╼╂╂╂╂┷		╌╂╂╂╌	-{{{ }}}	╂╾╂╂╌
Pitch Blas Fallure					 	
				-+++-	.,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	
			}		444444	
Gust Lock Not Disengaged					111111	
						ШШ
				ITI		
IFF In Operative	x		-17777	T		Π

TABLE 15. CONTINUED.

Parame Ten	PRIORITIES	NISSION PHASE	ENVIRONENT	DI SPL AY	FORMAT PROSE	FEED- BACK
	SAFTY M. SS. JON HALL INTERICE UMINECESSARY	TAZOFF PRUSE HAVE LAND SHUTDEN	MIGHT. DAY YANG YANG YANG YANG YANG YANG YANG YA	CATTICAL DIET CATTICAL DIET ACCESS DIET	OUNTITATIVE COMMITTATIVE COMBINED CAUTION ANTISON ANTO DESTINABLE ANTO NOT DESTINABLE	DISPLAT UNICESSAR
Eng. Anti-Ice On						
Pitot Heat On				4111		'-
				444		
Heater On		_!	4111111	444	1111111	
Heater Hot				444		
				4111	_{_{	 -
Caryo Huok Open					4444444	
Caryo Hook Armed			_{_{1111111	-1-11-		
			_ - - - - - -	-1111	-1414444	-
				-1111	-11!!!!!!	\dots
Parking Broke Om			_{-{11111}	1111	-1111111	 -
		+}}}	╼┠╂╂╂╂			 -
			_ - - - - - -			
Ing. Start Valve Open						\coprod
Master Caution	X			X		
	1111	111111	111111		11 111111	1_11

TABLE 16. AH-1G INFORMATION REQUIREMENTS.

PARAMLTLR	PRIORITIES	MISSION MIASE	ENV (ROMENT	DI SPLAY	FORMAT	RE - PORSE	BYCK LEED-
	SAFTY FISSION FAINTERANE JAMELESARY	TAKEOF CAUTSE HAVE LAVE SAUTGORN	BISHT DAY PMC INC NOT ALTITUDE	CONTINUAL CRITICAL DRLY ACCESS ONLY	QUANTITATIVE QUALITATIVE CONSINED CAUTION ADVISORY	AUTO DESTRACE AUTO NOT DESTRACE	DISPLAY UNITEESSARY
Fuel Quantity	x			×	x		
fuel tow	×						
fuel Pressure	x				×		
Fuel Pressure Low	x .				×		!
Fuel filter Obstructed	x				×	111	
Prime Boost Pump On	×						
Fuel Boost Pressure Low		1				<u> </u>	111
Governor Emergency	x			111	1111	<u> </u>	
					11111	1111	111
Engine Oil Temperature	x		111111	x			Ш
Engine Oll Temperature High	x			×			
Engine Oil Pressure	×			×	k		Ш
ingine Uil Pressure Low	x			×	kil		111
Engine Oil Quantity					11111	\prod	111
Engine Oil Quantity Low				1111		Ш	111
Oil Filter Bypass	×		<u> </u>	×		Ш	
Logine Chip	×] x]			Ш
The state of the s							
					1111		111
	11111	11111	1111111	1111		Ш.	111

TABLE 16. CONTINUED.

PARMETER	PRIORITIES	MISSION PHASE	ENVIRONMENT	DESPLAY	FORMAT	NE - PONSE	BACK FEED-
	SAFTY HISSION HISSION HISSION HISSION HISSION HINGESSARY	TAKEOFF CRUSS PUPER LAND	NIGHT DAY DAY INC INC ALTITOR	CONTINUAL CRITICAL ONLY ACCESS ONLY	GUANTITATIVE GUALITATIVE COMBINED CANTON	AUTO NOT DESTRUCT	DISPLAY UNICESSARY
111					1111	IIII	
EGI	×		111111	×	x	$\Pi\Pi$	刑
N _p	x			×	X		
Inlet Air Pressure Negative	x			×	×		-11
							i
Ng	x			l x	×		\prod
Engine Out					$\Pi\Pi\Pi$		\prod
N Control toop Energized							\coprod
					7 [] []		\prod
							\prod
XHSN 011 Pressure	×			×	T[[*]]		
NMSN 011 Pressure Low	x			×	×		
XMSN 011 Temperature							Π
XHSN 011 Temperature High	×			×	x		Π
Chip Main XMSN	x			×	x		Π
Chip Int XMSN	x		_{_{111111}}	×	x	$\Pi\Pi$	\prod
Chip tatt XMSH	x			_ x] ×		\coprod
MSN UI) Bypass	X			×	[<u>x</u>]		
	1111	11111			+1	{{{{}}}	$\{\}\}$

TABLE 16. CONTINUED.

PANAMETER	PI	tla	ŘΙ	110	ES	M	iss	10	. ,	HA!	i E	ξį	w	lac	104	EMT		(P1 S	PLA	Y	ı	FOE	Y4A	ı			E - CayS	£	;	ME
	CARTIN	WISSIGN	MAINTERANT	UMNECESSARY			TAKEOFF	2000		SWOTDOWN		wied.	200		¥		A TITUE			CRITICAL ORCY		AL PRINCIPLE OF THE PARTY OF TH	SUPPLIED THE PROPERTY OF THE P	COMBINED	CENTION	ANISORY		AUTO DESTRUBLE	The state of the s		DISPLAY UNHECESSARY
N _k	×	Ł				7	Ì	T	Ī			7	ľ	T		П	T		X		Ī	ļ	T	T	Ī	П	I	Ī	Τ	i	T
Majn Rutor Overspeed	T _x	T				7	1	1	T	T		1	T	1	T	П	1			X		7	T	×		П	I	T	T	T	T
Low Rator RPM	Ī,	T		П		7	1	1	Ť			T	Ť	T	T	П	T			X	T	1	Ť	×	П	П	T	T	T	i	T
	T	Π		П		1	1	T	T			T	T	T	T	П	T			T	Γ	T	T	Γ	П	П	I	Ī	Γ	!	T
	T					7	1	T	T			T	T	T		П	T			T		T	T	Γ	П	П	1	Ţ	T		T
1 Torque	×			П		J	T	Ţ	Ţ			Ţ	Ī	Ţ		П	T		X	Ţ		Ţ	T	×	П	П	I	1	Γ	1	T
	T					Ì	1		T	П		Ţ	Ī	T		П	T	Ĭ		T		T	T	Γ	П	П	П	T	Γ	T	T
	T					I		I	Ī			T	T	Ι		П	T			T		T	T	Γ	П	П	П	T	Γ	T	Ţ
Primary Serva Pressure Low						1	1	Ţ	T			T	Ī	I	I	\prod	I			I	T	I	T	Γ		П	\prod	Ī	Γ	T	Ī
Hydraulic Pump Pressure Low	T					1	1	7	T			T	I	T	T	П	1					T	T	П	П	П	I	T	T	T	T
Primary Servo Jam	I							I					Ī	Ī		П				1	Γ	T	T			П		T	T	T	Ī
Boost Servo Jam	Ι						1	T	T			T	Ī	T		П	Ţ			J	J	T	Ţ	Г	П		J	Ţ	Ţ	Ţ	Ţ
Boost Servo Pressure Law	I							\int	Ι					I		\prod	brack					T	Ţ					T	Γ		Ī
Tail Rotor Servo Pressure Low	I	L						ľ								\prod	brack I					T	Ι					Ι	Γ	floor	I
Backup Pump On	I]	I	L								I					I	F	\prod				m I	Γ	m I	I
flight Control Hydraulic Pressure	<u> </u> x								L								\mathbf{I}			x		Ι	I	\prod	X			I	Γ	brack	I
Utility Hydraulic Pressure							1										Ĭ					ľ		\prod				T	Γ		
							1	I						ľ						I		I	Γ					I			I
						J	I								Ĺ	\prod				I		Ţ	I				I	I			I
	1	ļ				-	ļ	1	1			1	ľ		١	H	1			I		Γ	ľ				I	T	1		1

TABLE 16. CONTINUED.

PARIMETER	PRIORITIES	MISSION PHASE	ENVIRONMENT	PISPLAY	FORMAT	RE- PONSE	FEED- BACK
	SAFETY HISSION HAINTENNICE UNHECESSARY	TAKEOFF CRUISE FOURE SAUTDOAN	NIGHT DAY DAY DAY DAY DAY DAY DAY DAY DAY DAY	CONTTRUAL CRITICAL DRLY ACCESS DRLY	QUARTITATIVE QUALITATIVE COMBINED CANTION	NUTO DESTRABLE AUTO NOT DESTRABLE	DISPLAY UNICESSARY
APU Exhaust Temperature High					11111		111
APU GI) Pressure Low	TITI						
APU Overspeed							
APU Underspeed					11111	111	Ш
APU Sequence Fall						11	
APU Fire							
APU Generator On	TIIIII			1 i			
APU On							Ш
'APU Tachqueter						Ш	
	TIIII				11111		
	1111						\coprod
Generator Output	×			×	×		Ш
AC Inverter Output tow	×			×	×		\coprod
Converter Output Low							\coprod
Rectifier Off							\coprod
Baltery Low Charge							
Battery Fault	TITIT						
, AC ESS Bus Off							Ш
OC Ess Bus Off	TITI						Ш

TABLE 16. CONTINUED.

PARAMETER	PRIORITIES	MISSION PHASE	ENV I ROIMENT	DISPLAY	FORMAT	RE- POISE	FEED- BACK
	SAFETY PATSSTON PATSTENANCE UNHECESSARY	TAKEOFF CRUISE HOVER LAND SHUTDOWN	NIGHT DAY DAY INC NOE ALTITUDE	CONTINUAL CRITICAL DNLY ACCESS ONLY	QUANTITATIVE OUALITATIVE CONSINED CANTON	AUTO DESTRABLE AUTO NOT DESTRABLE	DISPLAY DISPLAY UNNECESSARY
AC Load Meter					1111		\Box
DC Load Meter	×			×		$\Pi\Pi$	Π
							\coprod
							Ш
Engine fire							
Flt Path Stab Sys Fall							
Stabilator Auto Hode In Op		illi		1		$\Pi\Pi$	$\mathbf{T}\mathbf{E}$
Stabilator Position							Ш
		111111					
SAS OFF							\prod
							Π
						Ш	\prod
Pitch Bias Failure						$\Pi\Pi$	$\Pi\Pi$
						Ш	\prod
						$\Pi\Pi$	
Gust Lock Not Disengaged						IIII	\prod
							\prod
IFI In Operative				1111	717		

C. W. C. S. W.

TABLE 16. CONTINUED.

PRIORITIES	MISSION PHASE	ENVIRONMENT	DISPLAY FORM	RE- AT PONSE	BAC
SPETY HISSION HISSION WHICKSARY	TAKEOF CULTSE FAVOR SHOTOGIN	AT BELT PAY	CONTINUAL COLUMNICES ONLY ACCESS ONLY COLUMNITATIVE DUMITITATIVE	ADVISORY AND DESTRUCE AND WITH DESTRUCE	DISPLAT
					\prod
					\prod
		1111111	1111111	111!11	1
		44444	<u> </u>		1
			<u> </u>		Ц
	_!		 	<u> </u>	Ц
				111111	\coprod
!- -		-111111	 		H
		{{1},_{{1},{1},{1},{1},{1},{1},{1},{1},{1},{1}	┸╀╀┸┦╂╏		11
			┸╫┸╌╁╢		Ц
		_\\\\\	-1-1-1-1-1	111111	\coprod
	_ - - - -	_ - - - - - - - - - - - - - - - - - - -	┦╂╂ ╾╂╂╏	╁╏╂╏╁┨╼ ┤	H
		╼╂╂╂╂╂	╼╂╂╂╌╂╏╏	╂╂╂╂╂╼╌	H
	╼┼┼┼┼┼	╌╀╂╂╂╂	╃╂╂╼╂╂	╂╂╂╂╂	₩
		╼╂╉┽╂┿╟┤╸	┼┼┼┼	╁╂╂╀╂╌┙	₩
		-144414	-1-1+11-1		#
	-++++-	- -{-}}-}}	╌┠╌╏┼┼╌╌┼╁┼	┧╂╂╂╂	+
* - -	{-{-{ -{ -{ - - - - - - - - - - - - -	-1-1-1-1-1-1		14-11-1-	11
	ATTENDO ATTEND	SAMETY TAKEOF CAUTE TAKEOF CAUTE CAUTE TAKEOF SANITUMAN SANITUMAN	HATESTON HAT	SAFTY WISSION	PRIORITIES MISSION PHASE ENVIRONMENT DISPLAY FORMAT POINSE LINE TO THE PRIORITIES MISSION PHASE ENVIRONMENT DISPLAY FORMAT POINSE LINE TO THE POINT

TABLE 17. UH-60A MASELINE INFORMATION REQUIREMENTS.

PARAMETER	PRIO	RII	11 (ES	M	ISSI) ()	1 7	71	ASI	E	EM	71 5	101	HE	NT			DI:	SPI	LAI	'		FO	M	AT		_
		1	7	LINNE CESSEDY	ï	Ī	I	HOVER	Ī	Ī	Ī		DAY				ALTITUDE		CONTINUAL	CRITICAL DINIT	ACCESS ONLY	1		QUANTITATIVE	QUALITATIVE_	COMBINED	CAUTION	ADV1 SORY
Fuel Quantity	×					×	k	×	ļ	×		_				4				ļ						x		
Fuel Low	×		T			×	×	×	ļ	×			_							X						x		
fuel Pressure	,			T		×	x	×	þ	×										×							X	
Fuel Pressure Low	×		1	T	1	x	x	x	,	×		_	_			Н	1			×							X	
Fuel Filter Obstructed	×		T	T		×	×	x	×	4	Ī		\vdash			H				×		ŀ					×	\prod
Prime Boost Pump On		×	T	1		x	×	x	×		I									×		Ĺ						
Fuel Boost Pressure Low						1																						
		-	-	-	-	\downarrow	-	_		-		_	_			-	_		-	+	-	-	_				_	
Engine Oil Temperature	x	-	-	-	-	x	×	×	×	×	ł	-	-	-					╀	 ×		<u> </u>	_	-		x	_	
Engine Oil Temperature High	×	T	Ť		ľ	k	×	×	ļ	×	Ī	F	F	F	IΞ	Н	_			×	Ī	İ		_		x		
Engine Oil Pressure	×		1	1	ľ	×	x	x	×	×	Ī		F		1	Н	-			×		Ī				X		
Engine Oil Pressure Low	×		1	<u> </u>	ľ	x	X	×	,	√x	T			-	1 1	Ц		-		×	Ī	Ī				x		
Engine Oil Quantity		T	Ī	1]																						1
Engine OII Quantity Low			1	-																								
Oll Filter Bypass	×		Ī]		X	x	×	×	×		F	E			H	_			ļ	4					×		
Engine Chip	×	-	Γ	-		x	x	x	×] -	F	F	F	H				Ţ,	Ţ					X		

TABLE 17. CONTINUED.

PARAMETER	PRIORITIES	MI:	SSI	ON	PI	ASE	(ENV	lR	DNI	4E P	IT		DIS	PLA	Y	F	FOR	MA	T	
	SAFETY MISSION MAINTENANCE	UNNECESSARY	PRITSE	HOVER	LAND	SHUTDOWN		NIGHT	À	JEAN THE PROPERTY OF THE PROPE	100	ALTITUDE		CONTINUAL	CRITICAL DNLY		Altarettation	CUANT LIATIVE	COMPANED	CALTION	ADVISORY
TIT	×		xx		ī			7	1	Ŧ	1	1	Γ	Γi	x	Ī	寸	T	X	•	11
EGT	- 111	П	T	T	П			1	1	1	1	T	<u> </u>	П		T	7	T	T	t	Π
N _p	x	1	xx	×	×	x		7	7	7	‡	Ļ		П	x	T	7	1	×	Ţ	Π
Inlet Air Pressure Negative			T	-					1	1	1					I	1	+	T	+	\prod
			\dagger	\dagger					1	1	1					i	+	\dagger	†	\dagger	$\dagger \dagger$
Ng	×		х×	×	X	x			7	+	7	Ŧ			×	1		T	×		\prod
Engine Out	×		×	x	×				$\frac{1}{2}$	$\frac{1}{1}$	$\frac{1}{1}$	\pm			×			brack I	\prod	,	
N ₁ Control Loop Energized	-H		$\frac{1}{1}$							-	$\frac{1}{1}$						7	$\frac{1}{1}$	$\frac{1}{1}$	$ar{1}$	\prod
			\dagger					-		1	+	1	-		H	+	\dagger	\dagger	t	t	$\dagger \dagger$
XMSN 011 Pressure	×	×	×	x	x	X			4	$\frac{1}{1}$	$\frac{1}{1}$	-			x	T		T	T	Ţ	\prod
XMSN 011 Pressure Low	×	×	×	x	×	x			\Box	$\frac{1}{4}$		1			x					Ţ,	\prod
XMSN 011 Temperature	×	×	×	×	x	X				-	$\frac{1}{1}$	$oldsymbol{\perp}$			x			brack I	T	ļ	\prod
XMSN Oil Temperature High	×	×	×	×	x	x				-	$\frac{1}{2}$	\perp	L		x			brack I		ļ	\prod
Chip Main XMSN	×	×	×	×	x	x			_		1	1			x					,	\prod
Chip Int XMSN	×)	×	×	x	x			_}	_	-	+			x		Ţ			,	\prod
Chip Tail XMSN	×	,	()	×	×	x			\exists	1	1	\perp			×			T	I	Ţ,	\prod
XMSN O11 Bypass	×	Π,	(),	×	x	x		Ц	_	4	4	T	Γ		x			T	T	Γ,	Π

Contraction of the second

TABLE 17. CONTINUED.

PARAMETER P	PRIORITIES MISSION PHASE									E	ENVERONMENT					 DISPLAY			1	FORMAT						
	CAFFTY	MISSION	MAINTENANCE	UNNECESSARY	TAYFOFF		LOWER	HOVER	LAND	SHUTDOWN		NIGHT	DAY	VMC	IMC	NOE	ALTITUDE	CONTINUAL	CRITICAL DNLY	ACCESS ONLY		DUANTITATIVE	QUAL ITATIVE	COMBINED	CAUTION	ADV 1SORY
H _R	×	Ĺ			u	i	4	1				_		Н					x			×				Ц
Main Rotor Overspeed	x		Ì		x	þ	ξķ		x	x		_	L	H	Н	L	<u> </u>		×			k				
Low Rotor RPM	x	Γ	Ī		×	ļ	4	4	X			E	E		L				k						×	
			Γ				I																			
	T	Γ	Γ					Ī													i					
% Torque	×	Γ	T	Γ	×	þ	4	7				F	F	-	F	H			×					X		П
	T	T	T	Γ		T		Ī													i	Γ				Π
		T	T	Ī		T	Ī	Ì										Γ				Γ				П
Primary Servo Pressure Low	x	T	T	Ī	×	ļ	< k	;	x	X		E	E						k						X	
Hydraulic Pump Pressure Low	x	Γ	Γ	Γ	×	,	(k	ļ	x	X		_	_				L		×						x	
Primary Servo Jam	×	T	1	T	x	×	(k	,	x	X		F							×						X	
Boost Servo Jam	Tx				×	×	k	ļ	×	X			L	F					k						x	П
Boost Servo Pressure Low	1	×	T		×	×	k	,	×	X				-	-				×						X	
Tail Rotor Servo Pressure Low		×		Γ	×	,	κ		x	X			L						k						x	
Backup Pump On	\prod	x			×	×	k	ŀ	x	X		E		E	E	E			k							X
Flight Control Hydraulic Pressure	×	Ī	Γ		×	ļ	κ	.],	x	X		E	E	F		Ŀ			k						X	
Utility Hydraulic Pressure	×	Ī	T		×	,	(k	,	×	X			-	_					k						x	

TABLE 17. CONTINUED.

PARAMETER	PRIOR	11	16:	S 1	AIS:	12	ON	Pł	IAS	E	EN	VII	RO	NH T	EN	T	·	ÞI	SP	IJ	Ŋ	 F	ORI	HAT	<u> </u>	1-1
	SAFETY	MISSION	MAINTENANCE	UNNECESSARY	TAKEOFF	CRUISE	HOVER	LAND	SHUTDOWN		NIGHT	DAY	YEC	1 MC	202	AI TITITUE	700.00	CONTINUE	COTTICAL DIST	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	ALLESS UNL!	CHIANTITATIVE	OUAL TTATIVE	COMBINED	CAUTION	ADV 1 SORY
APU Exhaust Temperature High						Ī	Γ							I		}		T	Ī	1	}	 }	T			\prod
APU 011 Pressure Low		Γ	×		×				x		\perp	F	F	F	F	Ŧ	T	T	,	1	1	 T	T			K
APU Overspeed			×		×	Ī	T		x			F	F	F	Ŧ	Ŧ	1	T	k	1	1	 1	T	Γ		×
APU Underspeed			×		×				x			F	F	F	Ŧ	Ŧ	1	T	k			T	T			×
APU Sequence Fall		Γ	×		×	Γ	T		x				I	Ţ	Ţ	Ţ	T	T	K		1	T	T	Ī	k	П
APU Fire	×		Ī		×	T	T		×			F	F	T	Ŧ	Ŧ	\top	T	k		1	T	T	Γ	k	П
APU Generator On		×	T	Ī	×	Ī	T		x		F	F	F	Ŧ	Ŧ	Ŧ	7	Ī	K		i	T	T			×
APU On		×			x		T		x			-	1	Ŧ	Ŧ	7	1	T	K		Ī	T	T	Γ	Γ	×
APU Tachometer														I	I				I			I	I			
		-	-	-	 -	-	1	-			-	-	-	-	1	1	+	+	1			 +	1	1	-	
Generator Output		×		T	×	×	k	×	×		F	F	1	1	7	7	1	1	1	x		 T	T	T	×	
AC Inverter Output Low			T	T			T				T	T	1	1	1	1	1	T	1			 T	1	Ţ	T	
Converter Output Low		×	T		×	×	k	×	x		F	F	Ŧ	7	7	7	7	T	1	X		1	T	T	k	
Rectifier Off						T	T						I					I				I	T	Ī		
Battery Low Charge		T	×	I	×	T	T		×		F	F	Ŧ	Ŧ	7	7	-	J		X		J	J	Ī	×	
Battery Fault		T	Į,	1	×	,	Ţ,	d×	×			-	T	1	1		1	T	1	X		1	T	T	k	Γ
AC ESS Bus Off	×		T	T	x	✝	†	1-	×		-	1	1	1	1	1	1	1	1	X		T	T	T	k	T
DC Ess Bus Off	×]	T	1	II,	Ţ,	4	×	×		-	Ţ	Ţ	1	1	1	1	1	7	Y.		T	T	Ī	k	T
External Power Connected		×	T	T	×	1	7	T	×		1	1	1	1	1	1	1	1		X		T	T		T	×

TABLE 17. CONTINUED.

PARAMETER	PRIOR	17	IE!							E	EN	٧J	RO	NP4	EN	Ţ	·	DJ	SF	LA	Y		O	MA	T	
	CAPETY	MINITON	MAINTENANCE	UNNECESSARY	TAKEDEF	CRITSE	HOVER	I AND	SHUTDOWN		NTGHT	DAY	VMC	INC	NOE	ALTIME		CONTINUE	VIEW CONTRACTOR	ACCESS ONLY		ALIENTA PARTIE	COLD TARTOR		CAITING	ADVISORY
AC Load Heter					L				L		L	L														
DC Load Meter			L		L	Ļ	ļ	ļ	ig		_		-			_		+	1	1	_	1	1	-	+	ļ
		┞	+	-	-	-	\mid	\vdash	\vdash	 	-	-	┞	-	-	-	-	+	\dagger	\dagger	-	\dagger	\dagger	-	+	ł
Engine Fire	x	T	T		×	×	×	x	x		-		L	L	F				1,	1		T	Ī	Ī	,	1
flt Path Stab Sys Fail	x	Ī	T		×	×	×	×	x		_	F	L	F	L			T	ļ	4	1	T	Ī	T	Ī×	Ţ
Stabilator Auto Mode In Op	×	T	T		X	×	×	x	×		F	_		L		-		T	Ţ	4	į	I	Ī	Ī	ļ	4
Stabilator Position	х		I		×	×	×	×			L	F	L	F		F		Ţ	Ţ			1	ķ		F	F
		\mid	╀	┞	L	┞	╀	ŀ	\vdash		H	-		\mid	-	┞	\vdash	+	+	\dagger	\vdash	+	\dagger	+	╀	╁
SAS Off	×	 	- -		×	X	k	X	×						-			+	†,	1	İ	†	1		K	-
		H	-	┞	-	-	-	-	H		-	-	-	ŀ	-	┞	\vdash	+	$\frac{1}{1}$	\dagger	-	\dagger	\dagger	-	\vdash	+
Pitch Bias Failure		×	F		×	×	k	×	×		E	-			-			T	Ţ,	1	-	T	1		×	F
		+	-	-	_	$ar{}$		-	-					-		-		$\frac{1}{1}$	}	}	\vdash	1	+	+	+	\vdash
Gust Lock Not Disengaged		×	ł	-	x			-	×		E			F	F	-		I	Ţ	1			1		k	F
		-	-	-	-	-	-	-										$\frac{1}{1}$	1	+		-	+	+	+	-
IFF In-Operative		X			x	x	k	x			F	F	F	F	F	F		T	1	4		Γ	Γ	X		Г

TABLE 17. CONTINUED.

PARAMETER	PRIOR	IIT	IE:	S ,	415	SI	ON	P	HAS	E	EN	VII	ROI	ME	NI		į	DI:	PŁ	.AY		F		AT	7	7
	CAFFTY	MISSION	MAINTENANCE	UNNECESSARY	TAKEOFF	CRUISE	10/E	280	SHUTDOWN		NIGHT	DAY	₩ C	E.	2	ALTITUDE		CONTINUAL	CRITICAL DALLY	ACCESS ONLY		OUANTITATIVE	QUALITATIVE	COMBINED	CAULICA	ADVISORY
Eng. Anti-Ice On		×				x					E	E		\exists					×							Y
		L	-			_	-	L	-		-					_		_						+	$\frac{1}{1}$	
Pitot lieat On		×			×	×	×	k			E								×					†	1	×
	_	ŀ	L			-	ļ.	-													<u> </u> 	-	H	+	1	$\frac{1}{1}$
Heater On		†				 	r	ŀ	T		┢	┝			Н						1		H	1	1	1
Heater Hot																								1		
		-	-	-			ŀ	-	L		-	L						_		_			\prod	1	4	4
Cargo Hook Open		×	_		×	×	×	 x	×		L							-	×		_	L	H	+	1	×
Cargo Hook Armed		×			×	×	×	×	×		E								×					1	1	×
		-	-		-	-	-	-	-			-	L	Н		_	_	-	-	_	-	L	H	+	1	$\frac{1}{1}$
Parking Brake On		×			×			×	×										×					1	1	x
		-	-		-	L	-	-	-	 	-	-	-			_	_	_	L	_	-		H	+	+	-
Eng. Start Valve Open		-	×	-	×	-	-	-	-			-	-	-		-	_	\vdash	×		-		H	+	+	1
Master Caution	×	-	-	-	×	×	×	×	x							j / /			×						7	1

TABLE 18. CH-47C BASELINE INFORMATION REQUIREMENTS.

PARAMETER	PRIO	R 1 1	ILE	S	HI:	S	101	N	PH	AS	SE .	EN	I VI	RO	M	EN	T		01	SP	LA	Y	F	DRI	KA1	<u> </u>	
	CAPETY	MICCION	MAINTENANCE	INNECESTARY	TAKENEE	100000	LANCES	AND THE PROPERTY OF THE PROPER	LAND	SHUTDOWN		NIGHT	DAY	W.C.	INC	NOE	ALTITUDE		CONTINUAL	CRITICAL DNLY	ACCESS ONLY		OUANTITATIVE	QUAL ITATIVE	COMBINED	CAUTION	ADV I SORY
Fuel Quantity	x	1			II .	i	<u>d</u>	1	1			L	L	L	L	-	L			k			L		x		
Fuel Low	x		I		×	ļ	ψ,	ф	ĸ	x		L	L							k					x		
fuel Pressure	x	Ī	T	Ī	×	Ī	χþ	φ	(K										k						ĸ	\prod
Fuel Pressure Low			T	Ī			I																				
Fuel Filter Obstructed		T	T	Ī		I																					\prod
Prime Boost Pump On		Ī	T	Ī		Ī	T	Ī													Ĺ						
Fuel Boost Pressure Low																											
																				L	L						
Engine Oll Temperature	×	Ī			x	ļ	þ	ф	ĸ	x		\vdash	L	ŀ	-	\vdash	ŀ	$\left\{ \right.$		x			k				
Engine Oil Temperature High	×		T	Ī	×	ļ	()×	•	,	X			E							x			k				
Engine Oil Pressure	x				×	,	()×	()	·	X		L	L			F				x			k				
Engine Oil Pressure Low	x				×)	(x	×		X						E				x			k				
Engine Oil Quantity		Ī																									
Engine Oil Quantity Low		Ī																									
Oil Filter Bypass																				Ĺ							
Engine Chip	х				x	,	(x	×		×						L				X			ĸ				

TABLE 18. CONTINUED.

PARAMETER	PR	10	RI	TI	ES M	ıs	SI	DN	PI	HAS	E	EN	14	RO	M	EN	r_,	D	15	PL	.AY	F	081	141	1	
	SAFETY	MISSION	MAINTENANCE	UNNECESSARY		TAKEOFF	CRUISE	HOVER	LAND	SHUTDOWN		NICHT	DAY	ZEC -	INC	NOE	ALTITUDE		CONTINUAL	CRITICAL DNLY	ACCESS ONLY	DUANTITATIVE	OUALITATIVE	COMBINED	CASTION	ADVISORY
TIT		L					L		L			L	L	L	L				4		Ц.,	L				
EGT	×	L				X	×	X	×	×		上	t	t					1	X				×		
N _p		L							L	L												L				
Inlet Air Pressure Negative	-	_					-	L	<u> </u>			1	-	-	-							1		L	Ц	
	-	-	-	-		<u> </u>	-	L	\vdash	\vdash		+	-	$ar{L}$	-	-	-	H	1		1	+	H	_	Н	
Ng	x					x	×	×	×	×				-						×	İ			×		
Engine Out																										
N ₁ Control Loop Energized	x					x	×	×	×	×		F		I	F			П		X				×		
	_	_	-	_			-	L	_	-		-	L	-	-	-	-	H	4		-	-		_		
XMSN Oil Pressure	x		-	-		×	×	×	×	×		1	L	1	-			H	1	X	-	-		×	H	_
XMSN Oil Pressure Low	×	1	r			x	1-	r	r	1		L	T.	1	1				7	X		t		×		_
XMSN 011 Temperature	x		r				t-	i	f-	X		1	 	†	†	-	F	H	-1	x	1	1	x			
XMSN Oil Temperature High	x					x	×	x	×	X		T	T	1	t		-	\prod	1	X			X			_
Chip Main XMSN	×					×	×	X	×	X		E		I	L	I				X				×		_
Chip Int XMSN		ļ	L																							
Chip Tail XMSN		_	_				<u> </u> _							1			L									-
XMSN Oil Bypass			L				 	ļ.,,		_			L	L			_			-	-					-
	}	}	}	1			1		}	1		Į	Ì		}						 					_

TABLE 18. CONTINUED.

PARMETER	PF	110	RI	TI	ES I	41 S	SI	ON	P	HA:	SE	EN	VII	ROI	W	N	1	 DI:	SPI	LAI	!	F	000	441	r	-
	SAFETY	MISSION	MAINTENANCE	UNNECESSARY		TAKEOFF	78175	HOVER	LAND	SHUTDOWN		MISH	DAY	Y.C.	IMC	NOE	ALTITUDE	CONTINUAL	CRITICAL ONLY	ACCESS ONLY	 - -	QUANTITATIVE	TOUALITATIVE	COMBINED	CAUTION	ADVISORY
N _R	×	ŀ				×	×	×	×	×		L						L	×					X		
Main Rotor Overspeed	T									I																
Low Rotor RPM	Ī	Γ				Γ	Ī	Ī	Ī																	П
	T	Ī		Ī	Γ		Ī	T	Ī			Γ.			П								П			П
	T	T		r	<u> </u>		ĺ	T	T	r					П					Ī	i		П		П	Π
% Torque	×	T				×	×	×	T	T			F	Н	П			T	×			Г		×		П
	T	T		r	-	İ	T	T	T	T	 				П			Ī	Ī							1
	T	T		r		İ	T	Ī		r	_							T		Ī		Г		7		1
Primary Servo Pressure Low	T	Ţ		1					T																	
Hydraulic Pump Pressure Low	T	×		Ī		×	x	×	×	x		L			\Box			Γ	x					X		T
Primary Servo Jam	T	Ī		<u></u>				Γ																		1
Boost Servo Jam	T	T		Ī	Π						_															7
Boost Servo Pressure Low	T	T					l																			
Tall Rotor Servo Pressure Low	T	T		1			Γ																			
Backup Pump On	T	T	Γ	r																						\int
Flight Control Hydraulic Pressure	×					X	x	k	x	x			L						×					K		\int
Utility Hydraulic Pressure	×			-		x	x	×	x	X		_				-			k					,	1	1

TABLE 18. CONTINUED.

PARAMETER	PR	10	RJI	11	ES M	IIS	SI	ON	P	HA:	SE	EN	VI	RO	MM	EN	ī		DI	SF	<u>'</u>	\ Y	F	OR	MA	T	_
·	SAFETY	MISSION	MAINTENANCE	UNNECESSARY		TAKEOFF	CRUISE	HOVER	200	SECTION		MICH	NA NA	. AE	13C	NOE	ALTITUDE		PONT PRITAL	COTTICAL DISTA	ACCES ON V		CHANTITATIVE	GUAL TATTVE	COMBINED	CAUTION	ADVISORY
APU Exhaust Temperature High			X			x			L	x	L	L	L	L	L	L				×						Ľ	×
APU 011 Pressure Low			×			x				x			L	L						X					Γ		×
APU Overspeed			×			×				×		E	E		L	F				×	I		Γ	T	Γ		×
APU Underspeed			×			x				×			L	E						×			T	Γ	Γ		X
APU Sequence Fail								Γ											T	Ī	T		Γ	T	Ī		Γ
APU Fire								Γ											Τ	Ī	T	1	T	Γ			Γ
APU Generator On				_						Γ			Γ	Γ						T	T	i	T	T	Γ		
APU On										Γ		Г							T	T	T	T	T	1	Г		
APU Tachometer			П																Ī	T	T			Ī		П	
										Γ										Ī	Ī	ĺ	T			П	
			П	Ľ						Γ									T	T	T		T				
Generator Output		×				x	×	×	×	x		\vdash	F	F			T		Γ	×	T	T	T		П	x	
AC Inverter Output Low										Γ							T		T	T	T		T		П	П	_
Converter Output Low						1													Ī		T				П	П	
Rectifier Off	7	×				x	х	x	x	x						Н	H			x	Ī				П	×	
Battery Low Charge																			Γ	T	T				П	П	_
Battery Fault	1								Γ											Γ	T				П	П	
AC ESS Bus Off	1	T				П			-										T	1	T	1			П		٦
DC Ess Bus Off					П						r					П			Γ	Γ	T	1	П		П	П	٦

TABLE 18. CONTINUED.

PARAMETER	PR	101	RI'	111	S H	15	511	DH	PI	IAS	E	EN	VII	RON	ME	NT			216	PL	AY		F	XX	AT		,
	SAFETY	MISSION	MAINTENANCE	UNNECESSARY		TAKEOFF	CRUISE	ноуей	LAND	SHUTDOWN		NIGHT	DAY	VMC	W.W.C	WOE.	AL 1 1 DUE		CONTINUAL	CRITICAL ONLY	ACCESS ONLY		DUANTITATIVE	DUAL ITATIVE	COMBINED	CAUTION	ADV I SORY
AC Load Heter		X							l	x										X					ı	x	
DC Load Meter		X				X	×	×	X	×		F				+	1			×	_		_			×	
	_	_		-			-	-	-	-		\vdash	_		-	+	+	-						H		-	_
Engine Fire	x					x	×	x	×	×						1	1			×						X	_
Flt Path Stab Sys Fail																					İ						
Stabilator Auto Mode In Op						Ì																					
Stabilator Position						L								_									L			_	_
	<u> </u> -	L	_	H		-	H	-	-	\vdash		\vdash	\vdash	_		-	+	_					L	H		_	_
SAS Off	x	-	-	-		×	×	×	×	×		-	-	-		-	1			×			-	-		_ X	
	L	L	L	L		_	-	-	H	_		+	-	L	_	-	4	-	_	_			-	H	\vdash		
Pitch Bias Failure	\vdash	-	-	-		-	-	\vdash	-	\vdash		+	\vdash	-	-		1	-		_	-	_	\vdash	H		-	 -
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Gust Lock Not Disengaged																											
	_	-	-	-		-	-	-	-	\vdash		-	1	-	L					L	L		-	H	Н	H	_
IFF In-Operative	-	-	-	-	pa garde state _e ; j	-	ļ	-	-	-		1	+	+	-	H	-		-	-	-	-	 -	-	-	-	-

TABLE 18. CONTINUED.

PARAMETER	PRIORITIES	MISSION PHASE	ENVIRONMENT DISPLA	FORMAT
	SAFETY MISSION HAINTENANCE UNNECESSARY	TAKEOFF CRUISE HOVER LAND SHUTDOWN	NIGHT DAY VMC IMC NOF ALTITUDE CONTINUAL CRITICAL ONLY ACCESS ONLY	QUANTITATIVE QUALITATIVE COMBINED CAUTION ADVISORY
Eng. Anti-Ice On				
Pitot Heat On				
	++++-			
Heater On	11111	- 		
Heater Hot	x	x x x x	×	x
	++++		-+++++++++	
Cargo Hook Open	x	xxxxx	×	х
Cargo Hook Armed				
Wheel Dephased	+ x	x x x		X
Parking Brake On	x	x x	× ×	×
				
Eng. Start Valve Open	+++++			
Master Caution	x	x x x x x	x	
riaster caution	 	- x x x x x		- - - - <mark> </mark>

St. Kon

TABLE 19. OH-58C BASELINE INFORMATION REQUIREMENTS.

PARAMETER	PR	I OF	111	18	S M	ISS	10	W	PH	IAS	E	EN1	/11	RON	ME	NT		DI	SPL	AY.		FO	RH	AT	-	
	SAFETY	MISSION	MAINTENANCE	UNNECESSARY		TAKEOFF	CRUISE	HOVER	LAND	SHUTDOWN		NIGHT	DAY	VMC	1%	NOE	ALTITUDE	CONTINUAL	CRITICAL DNLY	ACCESS ONLY		QUANTITATIVE	QUALITATIVE	CONSTNED	ADV I SORY	
Fuel Quantity	×					x		l	x			-				$\frac{1}{1}$	-		×			Ц		x		
Fuel Low	x	П				x	x	×	x	x		-		H		\exists	-		×					×		
Fuel Pressure																									1	
Fuel Pressure Low																										
Fuel Filter Obstructed	×					x	x	×	x	×		L		L					ļ	ال				x	1	
Prime Boost Pump On		×				×	x	×	X	×		L	L	Ł	E	Н			ļ	4		L	Ц	×	1	
Fuel Boost Pressure Low	Γ																									
			Ī																$oldsymbol{\perp}$		_		L		1	
															L	L			1	L		L		Ц	1	
Engine Oil Temperature	×					×	×	×	×	×		<u> </u> -		Ŧ	L	L	L		Į,	4				x		
Engine Oil Temperature High	×					×	×	×	×	,		-	1	\pm	l	L]	4	<u></u>	L		×		
Engine Oil Pressure	×	T				×	X	×	×	,		F	+	\pm	+	Ł	E		1	1		L		X		
Engine Oil Pressure Low	×					×	×	,	d×	,		-		1	\pm	F	L]	×L		L		×		
Engine Oil Quantity		T	Ī																	\perp		floor				
Engine Oil Quantity Low																			1				L			
Oil Filter Bypass	×	T				×	×	,	4>	< >		_[1		\pm	1	Ł			×				×		1
Engine Chip	×		T			×	×	,	d,	()×		-	+	4	+	1	1			x				×		

TABLE 19. CONTINUED.

PRIOR	ITTES	MIS	SI	ON	P	HA:	SE	EN	VII	ROP	MI	ENT	r	1	DIS	PL	AY	F	OR	MA.	T	
SAFETY	MAINTENANCE UNNECESSARY	TAKEDEE	Centre	HOVER	LAND	SHUTDOWN		NIGHT	DAY	WC	IMC	NOE	ALTITUDE		CONTINUAL	CRITICAL DNLY	ACCESS ONLY	CHANTITATIVE	OUAL TTATIVE	COMBINED	CAUTION	ADV LSUKT
																					Ш	
x	11	\\x	,	d _x	×	×			L	Ц						×				×	П	
x		x	,	ďχ	x	X				H						X			Γ	×	П	}
	-			-		-												1	F			7
		<u> </u>															-	\dagger	1	-	H	1
x		1x	×	×	x	×										X			Γ	x	П	1
x		X	×	×	X	×										X		T	Γ	×	П	7
			ĺ	I														T	Γ	Γ	П	7
																		T			П	1
		T		T														\top	T	Γ	П	1
×		X	×	×	×	×				H	1					X				x	П	1
x		X	×	×	x	×										X		T		×	П	1
X		x	×	×	x	k						1				X		T		x	П	1
x		×	×	×	×	×										X		T		×	П	1
x		×	k	×	×	×										X		T		×	П	1
x		x	×	×	X	×		_	_							X		T	Γ	×	П]
x		x	×	×	×	×			_		-					X	1	1		x	\prod	1
															_			T	Γ		П	1
	X X X X X X X X X X X X X X X X X X X	X X X X X X X X X X X X X X X X X X X	X X X X X X X X X X X X X X X X X X X	X X X X X X X X X X X X X X X X X X X	X	X	X	X	X	X	X	X X X X X X X X X X X X X X X X X X X	X X X X X X X X X X X X X X X X X X X	X	X X X X X X X X X X X X X X X X X X X	X			X	X	X	

TABLE 19. CONTINUED.

PARAMETER	PR	10	R J	711	ES I	HIS	SI	ON	P	IA:	SE_	EN	VII	ROI	ME	NT		DI	SPI	LAI	!	F	OR	HA'	T	•
	SAFETY	MISSION	MAINTENANCE	UNNECESSARY		TAKEOFF	CRUISE	HOVER	- PAND	SHUTDOWN		NIGHT	DAY	VMC]¥C		ALTITUDE	CONTINUAL	CRITICAL DNLY	ACCESS ONLY		CHANTITATIVE	OUAL ITATIVE	COMBINED	CAUTION	ADV I SORY
N _R	x	1				ł	×	ł	1	×	ı	L				-	\exists		×	П		×			Ĺ	
Main Rotor Overspeed																	1									
Low Rotor RPM						Γ	Γ	Γ	Γ		Γ															П
	T									Γ	Γ						1						Ι		Γ	П
	Γ					Γ					Γ											Τ	Γ			П
% Torque	×					x	x	x				_		Н	П	4	7		x			T		×		П
	T				·											1	1					T				П
	T			Г		Ī	Г									1	1		Г			Ī				П
Primary Servo Pressure Low	T		Γ													1						T				П
Hydraulic Pump Pressure Low	×					x	x	x	x	x		_		Н	H	+	-		x						X	П
Primary Servo Jam	T																									
Boost Servo Jam	Ī	Γ	Ī																							П
Boost Servo Pressure Low	T																						•			
Tail Rotor Servo Pressure Low	Ī			T																						
Backup Pump On	Ι																									
flight Control Hydraulic Pressure																										
Utility Hydraulic Pressure		Γ	Ī	Ī	Ĩ											T	I									

TABLE 19. CONTINUED.

PARAMETER	PR	10	R1	75	iadle . Es m					HAS		EN	V 11	ROI	WH	EN1	ī	!	DĮ:	SPI	LA)	1	F	DRI	MAT	i	
	SAFETY	MISSION	MAINTENANCE	UNNECESSARY		TAKEOFF	CRUISE	HOVER	LAND	SHUTDOWN		KIGKT	DAY	YHC	INC	NOE	AL TITUDE		CONTINUAL	CRITICAL DNLY	ACCESS ONLY		OUANTITATIVE	OUAL LTATIVE	COMBINED	CAUTION	ADVISORY
APU Exhaust Temperature High	ł	ľ																									\coprod
APU 011 Pressure Low		Γ																									
APU Overspeed																											\prod
APU Underspeed																							L		L		Ц
APU Sequence Fail																									L		Ц
APU fire																			L						L		\coprod
APU Generator On																			L			1_					Ц
APU On																							L			L	Ц
APU Tachometer																								1			Ц
																									L		Ц
													L						L				\perp	1	L		Ц
Generator Output		×				×	×	×	ŀ	×		F	£	1	1	1	1	_		×				1	L	×	
AC Inverter Output Low		L										1			1		1			1	1	_	\downarrow	1			Ц
Converter Output Low	1	1_					L						L		1	1	1			1	1			1	1	1	Ц
Rectifier Off		L				L	L	L	L	L		1	L	1	1	1	\downarrow	_		1	1		1	1	Ŀ	L	
Battery Low Charge				_			_			1		1	1	1	1	1	1	1	1	1	1	_	1	1	L	1	
Battery Fault					}																						
AC ESS Bus Off															1								1		1		
DC Ess Bus Off										1_				_	1	1							1	\perp	_	L	
External Power Connected	1	1	1	1	1			l			1	-	-	-			1			1	1	1			:	L	

TABLE 19. CONTINUED.

PARAMETER	PR	l OF	111	116	is i	415	51	ON	Pi	HAS	E	EI	NV.	I RC	W	ŒI	(T		0	IS	PL	AY			O		IT		_
	SAFETY	MISSION	MAINTENANCE	UNNECESSARY		TAKEOFF	CRUISE	HOVER	LAND	SHUTDOWN			NIGHT.	DAY	The state of the s	IMC	NOE A: +: -: -: -: -: -: -: -: -: -: -: -: -: -:	AL I TUDE		CONTINUAL	CRITICAL ONLY	ACCESS ONLY			QUANTITATIVE	QUALITATIVE Constress	COMBINED	CAUTION	ADVI SORY
AC Load Meter																								╛	1	1	1		
DC Load Meter		×				x	×	×	ļ	dx		1	+	4	1	+	+	4	_	_	x			4	1	\downarrow	1	×	
	 -	Ц		Н		\vdash	-	╁	-	╁		+	$\frac{1}{1}$	+	1	$\frac{1}{1}$	+	1						+	+	\dagger	+		H
Engine Fire												1														1]		
Flt Path Stab Sys Fall						1																	_	1		1			
Stabilator Auto Mode In Op						i																	_	╛		_	╛		Ц
Stabilator Position			L			I													_		L	L	L	4	4	4	4		L
	<u> </u>	-	-	-		+	-	+	+	╀		-	-			Ц	4		_	\vdash	\vdash	-		-	\dashv	+	-	-	_
SAS Off	-	-	-	-		╀	1	+	╁	+	-	┪	-							-	┞	┝	\vdash	1	\exists	1	-		\vdash
303 (1)	<u> </u>	\mid	-	\vdash		\dagger	t	\dagger	\dagger	\dagger	-	7		-						-			 	1			1		
									İ																				
Pitch Bias Failure	$oldsymbol{\perp}$		L	L		\downarrow	ļ	1	1	\downarrow		_	-	_	L				_	L	-	L	<u> </u>	_{			-	_	L
	-	-	-	-			1	+	╀	╀	-	-	-	_	L	L		L	<u> </u>	-	-	╀	╀	-	-	H	_	_	-
Gust Lock Not Disengaged	╁	+	-	-	 	+	}	$\frac{1}{1}$	1	-		-	_	-	-	-		-	-	-	1	\dagger	-	-	_	H	-	-	1
and the manufage	╁	+	-	t		+	\dagger	\dagger	†	1		_	_	-	-		-				l		T						
	T	1	T	1		1			Î	T																			
1FF In-Operative			-	T		-	T		ľ	-																			l

TABLE 19. CONTINUED.

PARAMETER	PR	10	RII	11	ES P	115	SI	DH	P	HAS	E	EN	711	101	PAE	NI	·	D1:	SPL	.AY	! 	F)6 0	MT	!	
	SAFETY	MISSION	MAINTENANCE	UNNECESSARY		TAKEOFF	CRUISE	HOVER	LAND	SHUTDOWN		NIGHT	DAY	VAC	IMC	NOE	ALTITUDE	CONTINUAL	CRITICAL ONLY	TACCESS ONLY		DUANTITATIVE	DUALITATIVE	COMBINED	CAUTION	ADVISORY
Eng. Anti-Ice On																									П	
1.								Γ	Γ														П			
								Γ	Ī													T			П	
Pitot Heat On									Ī																П	
																							Π		П	
																						Γ	П		П	
Heater On																							П			
Heater Hot																										
Cargo Hook Open																										
Cargo Hook Armed																										
					1		L																			
Parking Brake On		_	Ц																							
			Ц										L													
					 			L																		
Eng. Start Valve Open																										

TABLE 20. AH-1G BASELINE INFORMATION REQUIREMENTS.

PARAMETER	PR	1 OF	? ! 1	116	s M	155	10	W	PI	IAS	E	EN	٧I	RO	101	EN	T	.	DI	SP	LA	Y	FO	RH	AT		_
	SAFETY	MISSION	MAINTENANCE	UNNECESSARY		TAKEOFF	CRUISE	HOVER	LAND	SHUTDOWN		MIGHT	NAV.	JANA		308	AL TOTALINE	120111	CONTINUE	CETTICAL DINIT	ACCESS ONLY		DUANTITATIVE	QUALITATIVE	COMBINED	CAUTION	- VIOLI SOLUTION TO
Fuel Quantity	×					li		×	l	X		L	-	\downarrow	‡	$\frac{1}{4}$	+	1		Į,	4	_			x		
fuel Low	×					x	X	x	×	x		Ŀ	Ł	ł	ł	$\frac{1}{4}$	ł	1	1	þ	1	_		Ц	×		1
fuel Pressure	×					×	X	×	k	×		E	Ł	1	1	1	+	1		þ	1		\perp	Ц		×	╽
Fuel Pressure Low	×					X	X	×	k	X		F	ł	1	1	$\frac{1}{2}$	1	1		þ	4	_		Ц		×	
Fuel Filter Obstructed	×	Ī	Ī			×	X	×	k			L	Ŀ	1	1	1	1	┸	\downarrow	þ	4		\perp	Ц	Ц	×	1
Prime Boost Pump On	×	Γ				x	x	×	k	×		L	ł	1	1	1	1	Ł		þ	4	<u> </u>			Ц	X	
Fuel Boost Pressure Low		×	ľ			k	x	×	k	×		Ŀ	ł	1	1		╁	┫.		4	4		$oldsymbol{\perp}$			×	
Governor Emergency	×	I				×	×	k	k	×		F	1	1	1			1			4			L		×	
	T											1							1		1	1	1	L		Ц	
Engine Oil Temperature	×			Ī		k	×	×	k	×		ŀ	1	1	$\frac{1}{2}$			1			ĸ					×	
Engine Oil Temperature High	×		T	T		×	×	,	ķ	×		L		_				1			×	<u> </u>				×	Ц
Engine Oil Pressure	k	T	Ī			k	×	,	ķ	×		-	1			Н		_			x			l		×	L
Engine Oil Pressure Low	k	T		Ī		×	×],	(x	ξ, X		-	_				Н	1	1		ĸ			1	Ŀ	×	Ľ
Engine Oil Quantity		I																	_				\downarrow		1		
Engine Oil Quantity Low		I															L		_				┸	1	Ļ	Į.	L
Oil Filter Bypass	\[\bar{\chi}{\chi}					×	ļ	\phi	()	4		ŀ	1		<u>_</u>		-	H			Ł		1	\downarrow	\downarrow	Ľ	L
Engine Chip	7	4	Ţ			×	ļ	K P	()	4	4	ŀ	-		L	F	ŀ	H			×]_	×	

TABLE 20. CONTINUED.

PARAMETER	PR	I OR	t I I	711	s M	ISS	16	Ж	PI	IA:	SE	ENV	IR	01	ME	N	ľ		DI:	Pt	Α١.	!	FC	DRH	MT		_
	SAFETY	MISSION	MAINTENANCE	UNNECESSARY		TAKEOFF	CRUISE	HOVER	LAND	SHUTDOWN		NIGHT	DAY	VMC	IMC	NO.	AI TITUDE		CONTINUAL	CRITICAL ONLY	ACCESS ONLY		QUANTITATIVE	QUAL ITATIVE	COMBINED	CAUTION	ADV ISORY
TIT	Γ					·									L		L			L					Ц		
EGT	x					x	x	×	x	×		\vdash		L	Ŀ	Ł	ŀ	<u> </u>		×			\perp		×		
N _p	x					×	x	k	×	×		Н		L	L	ł	ŀ	1		×		_	$ prescript{1}{}$	L	X		Ц
Inlet Air Pressure Negative	×					×	×	k	k	×		T		Ł	-	L	ł	1	Ļ	×		L	\downarrow	Ļ		X	
								L		ļ			_	L		1	ļ	\perp	$oldsymbol{ol{ol{ol}}}}}}}}}}}}}}}}}$	ļ		1_	\downarrow	L	L	Ц	Ц
	L		L	L		1	L						L					1	1	1		<u> </u>	\downarrow	\downarrow	L		Ц
Ng	x					x	×	ŀ	d>	d	4		L	L	Ł	ł	†	1_	Ĺ	1	4	<u> </u>	$oldsymbol{\perp}$	Ļ	×		Ц
Engine Out						L					1					1		1_	Ţ	1	1		1	l	L		Ц
N ₁ Control Loop Energized												 L	L		1	1	1	\perp	\downarrow	\downarrow	1	<u> </u>	\downarrow	1	1	L	Ц
																			1					1	L		Ц
	\mathbb{I}											 L	L								1		\downarrow	1		L	Ц
XMSN 011 Pressure	X					×	þ	k	,	K)	×	 L	Ł	ł	1	+	1	-					\perp	1	×	L	
XMSN 011 Pressure Low	×					×	ļ	ķ	1	×Į:	K	Ŀ	Ł	1	1	1	┨	_	1		4	\perp	\downarrow	1	Į×	L	
XMSN 011 Temperature														\downarrow	\downarrow	1		\perp	1	1	1	1	1	1	1	L	
XMSN Oil Temperature High	×					×	þ	4		×	X	 1	1	1	╁	1		1	1		4	_]	1	×	L	
Chip Main XMSN	ļ					×	ŀ	4		x]	X	 Ŀ	1	╁	+	╁		1	1		9	\perp	1	1	1	1	
Chip Int XMSN	,	3				×	ļ	4	ا	x	X]					_	1				_	1	1	ŀ	4	
Chip Tail XMSN	,					×],			X	X							1				1_	1	1	ļ	4_	
XMSN Oil Bypass	_ ×					k	1	ĸ}	- 1	×	X	 ŀ		1			Н].		<u> </u> ,		

TABLE 20. CONTINUED.

PARAMETER	Pi	RIC	DRI	ITI	ES	HIS	SI	ON	P	HA:	SE	EN	N1	RO	NH	EN	r	DI	SPI	LAI	<i>'</i>	F	DAI	MA	<u> </u>	
	CAECTV	MICHIGA	MATUTEMBATE	INNECESTABY		TAKENEE	Tell Tree	HOVER	AND	SHUTDOWN		NIGHT	DAY	YEC	130	MOE	ALTITUDE	CONTINUAL	CRITICAL DNLY	ACCESS ONLY		CUANTITATIVE	OUAL ITATIVE	COMBINED	CALTION	ADVISORY
N _R	×		T	T	Γ		:			×		_	F	F	F	H	H		k			×			Ī	
Main Rotor Overspeed	×	T	T	T	Γ	×	k	×	×	×		F	F	F	F	H		Γ	×			×		Γ	Γ	
Low Rotor RPM	×	T	T	1	Ī	×	×	×	×	×	T	F		L	F	F		Γ	×	Γ		Γ		Γ	×	П
	T	T	1	T	Γ	T					T		Γ	Ī	Γ			T	T						Γ	
	T	T	T	T	Γ	T	T	T	Ī	Τ					Γ					Γ						
% Torque	×	T	T	T		×	×	×	ſ	Γ		F	F	F	F	H		T	×		<u>.</u>			×		
		Ī	T	T		Ī	Ī	T	Ī		Γ			Γ	Γ			Ī			i					
	T		T		Γ	Ī		T	Ī																	
Primary Servo Pressure Low			T	T		T		T		Γ																
Hydraulic Pump Pressure Low			Ī				Ī			Γ																
Primary Servo Jam																										
Boost Servo Jam		Γ																								
Boost Servo Pressure Low						L																				
Tail Rotor Servo Pressure Low																										
Backup Pump On																				Ĺ						
Flight Control Hydraulic Pressure	×					×	x	×	×	×		L		E	E	Н			x				j	X		
Utility Hydraulic Pressure																										
	-		-	-		_	_	_	_	_		_	_	_	_	_	-	 -		-		_	_	_	_	_

TABLE 20. CONTINUED.

PARAMETER	PR	101	811	11	S M	ISS	10	W	PH	AS	E (EN	/16	Ю	ME	MT		C	15	PL	AY		FI)A)	M	·	_
	SAFETY	MISSION	MAINTENANCE	UNNECESSARY		TAKEOFF	CRUISE	HOVER	LAND	SHUTDOWN		NIGHT	DAY	VMC	IMC	NOE	ALTITUDE		CONTINUAL	CRITICAL ONLY	ACCESS ONLY		DUANTITATIVE	OUALITATIVE	COMBINED	CAUTION	ADV1SORY
APU Exhaust Temperature High	1																				L		L		L		
APU 011 Pressure Low																									L		
APU Overspeed																				L			L	L	Ļ		
APU Underspeed														L			L						L				
APU Sequence Fail															L	L			L	L	L		L	1	L		L
APU Fire													L						L	L	L		1	1	L		L
APU Generator On		I													L		L		L					1	L	L	L
APU On																									L		L
APU Tachometer												L			l		L	<u> </u>	L	L			1	1	\downarrow		1
																							1		l		1
														1			L		L		1	_		1	1	1	1
Generator Output		×				x	×	×	×	×		Ŀ	1	ł	1	$\frac{1}{2}$	Ł	_	L	ķ		_		1		k	1
AC Inverter Output Low		×		L		×	×	×	×	×		1-	Ŧ	\downarrow	Ŧ	$\frac{1}{4}$	£	1_		ļ	4	_	1	1	1	k	1
Converter Output Low				L			L				<u> </u>								L	1		_	1	1	<u> </u>	1	╧
Rectifier Off											<u> </u>			1	1	\downarrow	1			\downarrow	1	\perp	1	1	1	1	1
Battery Low Charge													1	1		floor	_	$oldsymbol{\perp}$		_	1		1	\downarrow	ļ	1	1
Battery Fault																											
AC ESS Bus Off	I	I	Ī																	\int			1		1		1
DC Ess Bus Off																							1		<u> </u>		

TABLE 20. CONTINUED.

PARAMETER	PI	110	RI	TI	ES	HIS	25	101	H [AHC	SE	EN	VII	ROP	ME	NT		01	SPI	LAI	<u> </u>	F	060	W)	! 	_
	CAFFTY	MISSION	MAINTENANCE	UNNECESSARY		TAVEORE		LANGE	- AND	SHUTDOWN		NIGHT	DAY	VMC	ž		AL 11 TUDE	CONTINUE	CRITICAL DNLY	ACCESS ONLY		OUANTITATIVE	QUALITATIVE	COMBINED	CAUTION	ADVISORY
AC Load Heter	T	1	Ī	Ī			Ī	1	1	T								1								
DC Load Meter		×				×	Ţ	ķ	4×	×						7			k						×	F
		┞	-	-		+	+	+	$\frac{1}{1}$	+		\vdash	L		1	$\frac{1}{1}$	+	+	-			┞				L
Engine fire		Ĺ	Ĺ			<u> </u>	İ	Í										<u> </u>								L
Flt Path Stab Sys Fail						1													Ĺ							
Stabilator Auto Mode In Op						i				Ι											İ					
Stabilator Position						\downarrow	Ţ	\downarrow	$oxed{1}$							_		Ļ	L							L
	<u> </u> -	-	-	ļ			1	\downarrow	+	+		-		Н	\parallel	+	+	+	\mid	ŀ		-		Н	Н	
SAS Off	-	┝	-	\mid		+	$\frac{1}{1}$	\dagger	$\frac{1}{1}$	╁		-		-		1	╁	+	-	┞		\vdash	H	Н	-	_
									1										I							_
	_	L	_	_	·	_ _	-	. _	1	1	ļ			Ц		4	_	\downarrow		L		L				_
Pitch Bias Failure	L	L		-	 	\bot	1	+	+	1		-		L	Н	-	-	+	-	-	-	-			Н	_
	ŀ	┞	-	-		╁	\dagger	+	+	╁		-	_	H	-	1	╁	+	┞	╀	-	_	H	\dashv		_
Gust Lock Not Disengaged	-	-	\vdash	ŀ		-	1	\dagger	╁	\dagger		╁	-	1			+	\dagger	t	\vdash	 	H				_
																										_
									I									T								_
IFF In-Operative	Γ		ľ	1		7	T	T	T			1		П	П		1	T	T				Γ	7	7	_

TABLE 20. CONTINUED.

PARAMETER	PR	ORI	TI	ES M	15	210	M	PH	IAS	E	EN	VIR	ON	ME	NT		(DIS	PL	AY.	FC)RM	MT		_
	SAFETY	MISSION	UNNECESSARY		TAKEOFF	CRUISE	HOVER	LAND	SHUTDOWN		NIGHT	DAY	WIC	INC	NOE	AL TI TUDE		CONTINUAL	CRITICAL DNLY	ACCESS ONLY	QUANTITATIVE	QUALITATIVE	COMBINED	CAUTION	ADV I SORY
Eng. Anti-Ice On																									
	П		П																						
Pitot Heat On																									
Heater On																									
Heater Hot																									
Cargo Hook Open																									
Cargo Hook Armed																		L	L						
						_						L				L									
	\coprod							1				L.				L									
Parking Brake On						L		Ţ							L		_	L				Ц		L	
														L					L					,	
Eng. Start Valve Open																									
Master Caution	x				X	x	k	X	X		-	L	L	L	H	L			×					X	

TABLE 21. SIKORSKY PILOT CONSENSUS.

PARMETER	PRIORITIES	MISSION PHASE	ENVIROIMENT	DISPLAY	FORMAT	RE- FEE PONSE BAC	
	SAFETY MISSION PALINTERANCE IMMEGESSARY	TAKEOFF CRUISE HOVER LAND	MIGHT DAV DAV DAV INC MOE ALTITOR	CONTINUAL CONT. CONTINUAL CONTINUAL CONT.	QUANTITATIVE COMINED CONGINED CANTON ADVISORY	AUTO DESTRABLE AUTO MOT DESTRABLE DISPLAY	DISPLAT UMRECESSART
Fuel Quantity	x	xxxx	X X X X X	x			L
Fuel Low	x	xxxx	XXXXXX	x	$ \mathbf{x} $	l x	L
fuel Pressure	l x					-	${ m I}$
Fuel Pressure Low	х .	XXXX	XXXXX	l x	x	l x	L
Fuel Filter Obstructed	x	XXXXX	XXXXXX	l x	1	1 4	I
Prime Boost Pump On	x	xxx	XXXXXX	x		j _x	
Fuel Boost Pressure Low	x	x x x	XXXXXX	x !	x	k l	\perp
							L
Engine Oll Temperature	x	X X X X X	XXXXX				
Engine Oil Temperature High	x I	XXXXX	x x x x x		X	k	\mathbf{L}
Engine 011 Pressure	x l	XXXX	XXXXX	_x	l x		L
Engine Oil Pressure tow	k	XXXXX	_ x	x			Γ
Engine Oil Quantity	x				11111		\perp
Engine Oil Quantity Low	x	x	_ X X X X X				
Oll Filter Bypass	x	xxxxx	X X X X X		l l x		1
Engine Chip	x	x x x x x	_ x x x x x x				L
<u></u>							
			<u>. </u>		<u> </u>	-	
	11111			1111.			L

TABLE 21. CONTINUED.

PARAMETER	PRIORITIES	HISSION PHASE	ENVIRONMENT	DISPLAY	FORMAT	NE- PONSE	BACK BACK
	SAFETY HAINTENNE HAINTENNE	TAKEÖFF CRUISE CRUISE LAND SAUTBOAN	JATGHT DAY PHC 1PMC MOSE ALTITUDE	CONTINUAL CRITICAL ONLY ACCESS ONLY	GUANTITATIVE CUALITATIVE COPSINED COPSINED AUVIONA	AUTO DESTRABLE AUTO NOT DESTRABLE	DISPLAY UNIVECESSARY
TIT	x	x x x x	k x x x x x	<u> </u>	x	kI	'x
EGT	×						\prod
Np	×	xxxxx	x x x x x x	×	×	x	
Inlet Air Pressure Megative	ı, x						111
		_!}}}			-14141	1!!	
		!} }	-111111	 	4444		44
N _g	X	x x x x	* * * × × ×	<u> </u>	<u> </u>	×	444
Engine Out	x	xxxxx	k		<u> </u>	<u> </u>	
N ₁ Control Loop Energized	x	xxxxx	k		1111	x	×
							111
		<u> </u>		1111		Ш	Ш
XMSN 011 Pressure	×	x x x x x	x xx x k x	×			Ш
XMSN 011 Pressure Low	×	xxkxx	x x x x x		×	k	Ш
XMSN 011 Temperature	x	xxxxx	×××××	x	x	ļķ	
XMSN Oil Temperature High	×	xxkxx	×××××	111	1114	\prod_{k}	111
Chip Main XMSN	x	×××××	××××××	111	_		111
Thip Int XMSH	x	×××××	xxxxxx				111
Chip Tail XMSN	x	xxxxxx	xxxxxx	_ _ _			111
XMSN 011 flypass	x	x x k x x	x x k x x x	<u> </u>	<u> </u>	<u> </u>	411
	11111	111111					111

TABLE 21. CONTINUED.

PARMETER	PI	110	RII	ies	HIS	SI	09	1 6	PILLA	SE	E	(¥ [R)4 9 4	E	ıT		DI	SF	۲. <i>۱</i>	¥		ŧ	OR	MA	T	.	_	RI P(-	SE		-	FEE	D-K
	CARTO	MISSION	MAINTENANCE	UMNECESSARY	TAKENEE	Course	HWEB		SKITTON		2002				355	ATTE		Photo and B.	PATTING THE	ALTER SELVE			CHARTTARTYE	QUAL TTATIVE	COMBINED	CALTTON	Arwieney	The state of the s	Street Describer 5	AUTO DESTROOM	AUTO NOT DESTANDILE			DISPLAY	UINTERESTATION
N _R	×				-7-	7	1	i	×	1	k		ŀ			×		×	Ì		Ī				k	Ī	l	Ī	Í	J	x		i		1
Main Rotor Overspeed	×	Γ	П	7	Tx	×	ŀ	K	×		k	×	ŀ	Ţ,	Į,	×		Ī	k	\mathbf{I}	T		l	l		×		I	I		×		1		I
Low Rotor RPH	×		П	T	X	×	k	k	X		k	×	ŀ	Į,	J	×		I	ļ	I	I		Ι	I		ķ	I		ì	1	×		Ì	I	I
	T				Ι			I	I			I	I	I	I	I	L			I	I						I	I	1	1			1	brack I	Ι
									I		I			I				brack brack	I	I	i	_						I	1	Ī					
1 Torque	×				×	×	Į,	Į,	, x		k	k	ŀ	ķ	k	Į,		Į,	J		i				×				ļ	ا ل			1	1	1
	I				Ţ			I			L			l						1	İ								1				1	1	1
					L		L	Ī				I									Ĺ				L								1	1	1
Primary Servo Pressure Low	×				x	×	ķ	ķ	×		×	k	I	ŀ	k	×				×		_	L			Į,	1	I	1	1	×		1	1	1
Hydraulic Pump Pressure Low	×			l	×	×	ļ	ķ	k		×	k	ŀ	k	,	ďχ		l	,	×	-			l	L	ļ,	1			Į	×		1	1	1
Primary Servo Jam	x				×	×	×	ķ	×		×	ŀ	Į	k	Į	d×			Į,	Ţ	I		L			ķ		I			×		1	I	I
Boost Servo Jam	×				x	×	×	k	k		×	×		k	Į,	į,		1	Į,	ķ	1	_	L	L	L]×							1	1	1
Boost Servo Pressure Low	×				×	×	ķ	k	k		Į,	L	1	k	J	k			ı	1			L	Ŀ	L	L		1	l		ا		1	1	1
Tall Rotor Servo Pressure Low	×				k) _x	k	k	k		Į,	L	1	١,	ļ	L		1	1	4		_	L	L		Ļ	1				ا		1	1	1
Backup Pump On	k		Ц	1	×	×	ķ	k	k		1	1		×	ŀ	k		1	1	1	1		L	L	L	k	1	l	1		4	_	1	1	1
Flight Control Hydraulic Pressure		k			k	k	ķ	k	k		Į,	L		Į,	ļ	k		1		ا	1		L	L	k		l	1	1				1	1	1
Utility Hydraulic Pressure		k]	k	k	ķ	k	k		×	Į,		ķ			1			ķ	1				k	L								1	
			Ц													1]			Ĺ			ĺ						1	1	1
				-	. _			1	1		-			1	1				1				L		1		Į.	1						_	
	1	1		1	-	{	-	1	1	{	1	ļ	1	1	1	1		-	-			٠.	1.	1	<u>.</u> .	١.	1.	1.	1	1	1		_	1.	1

TABLE 21. CONTINUED.

PARAMETER	PI	101	RII	T [{	rs H	IIS	SIG	DN	PI	IAS	E	EN	V۱	RC	H	NE IN	17	_	Đ	15	PL.	AY	F	OA	w	T			P	E - ON	SE	FI	KED.	-
	ALIAN	MISSION	MAINTENANCE	UNNECESSARY		TAKEOFF	CRUISE	HOVER	280	SHUTDON		MICH		, Alec			AL TITLE			CONTINUAL	CRITICAL ONLY	ACCESS ONLY	GIANTITATIVE	MIAI TTATTOE	200000000000000000000000000000000000000			MOSTAGE		AUTO DESTRABLE	AUTO NOT DESIRABLE	DISPLAY	DISPLAY UNNECESSARY	
APU Exhaust Temperature High			X		х		Ī			×		Т	k	T	Т	Τ	k	Т		Ī	x	Ī	Ι	Ī	Ī	۱	[T	Ī	x		l,	П	
APU 011 Pressure Low		П	x		x					ķ		x	ķ	Ī,	×	k	k	T	1		×	1	T	Ī	Ī	Ī,	Ī	Ī	Ī	x		Ī,	П	
APU Overspeed	T	П	x		х					k		x	Г	Γ	k	Ŧ	Τ	I			ĸ			I	Ţ	Ī	Ī	Ī	Ţ	ľ		ļ	П	
APU Underspeed		П	X		×					×		×	ļ	Ŧ	k	I	F	Ι			x			I	Ì	Į,	J		١	× l		:	,	
APU Sequence Fall	\Box	П	×		x					×		x	×	ļ			J				x I	İ		ĺ	ĺ				j	 ¥		:	×	
APU fire	×	П			х					k		k	×	,	,	ф	,	,	I		x	ļ	 Γ	ľ	Ī	Ī,	J	I		x١		l _x	П	
APU Generator On		×			×		П			k		k	×	,	Ţ,	4	,	J	Ī		×	Ī	Ī	Ī	Ī	T		Ţ	Ī	٦		ĺ,	П	
APU On	\neg	X			х					x		k	×	ŀ	Į,	Ţ,	,	×	1		×		Ī	Ī	Ī	T	Ī	1	Ī		x	Π	П	•
APU Tachometer				X	×					x		k	×	k	Į,	4		ď			×				Ī	ļ	,	I	I		x	Γ	П	i.
	_													١		I	1						I	Ī	I	Ī	Ì	I	I			Γ	П	
		Γ		П						I			T	1	Ī	Ī	Ī						1	Ī	Ī	1	1	1	1			T	П	•
Generator Output	×	Γ				×	×	x	x	×		Tx	Ţ,	4	,	\ \	,	Ţ			X		Ī	Ī	Ī,	Ţ	Ī	1	1	_	X	Γ	П	
AC Inverter Output Low		x				×		X	X	×		×	Ţ,	,			x x	7			x		Ī	Ī	1	Į	Ī	1	1	x		Ţ	П	
Converter Output Low		x				x	×	×	х	F		×	Т	т	т	т	×	-1			X		Ī	Ī	T	Ī	×	Ī		X		k	П	
Rectifier Off		×				×	×	X	X	k		×	ļ	4	x ,	Į,	××	4			X		Γ	T	Ī	Ţ	χĪ	1		×		k	П	
Battery Low Charge		Γ	X			x	x	X	×	×		×	ļ	Ī	x,	4	ď	×			X		Γ	Ī	Ī	Ţ,	Į,	Ī	1		X	Γ	П	
Battery Fault		×				×	×	x	×	×		×	Į,	Į	×þ	4	,	×			X			Ī	Ī	Ţ,	,	Ī	1		x	T	\prod	
AC ESS Bus Off				X		ľ			-	-			ľ	1	Ī	1	ľ	T			-	Ī	T	T	T	T	1	1	1			T	П	
DC Ess Bus Off		Π		X		-				Γ			Ī	Ī	Ī	1	T	Ī		-		П	T	Ī	Ī	Ī	1	Ì	7			T	П	•
External Power Connected	×		Γ		х	-				k		k	k	1	1	4	4	4	_		×	-	Ť.	ľ		T	ļ	,	1	-	X	T	П	•

TABLE 21. CONTINUED.

PARMETER	PRIORITIES	MISSION PHASE	ENVIRONMENT	DISPLAY	FORMAT	RE- PONSE	PEED- BACK
	SAFETY HISSION HAINTHANCE UNINECESSARY	TAZOF CRUISE HOYER SMITDON	MIGHT DAY WC WC THE ALT TUBE	CONTTRUM. CRITICAL DILY ACCESS ONLY	QUANTITATIVE QUALITATIVE CONSINED AUTION	AUTO DESTRUBLE AUTO NOT DESTRUBLE	DISPLAY UNNECESSARY
AC Load Meter	×						:11
DC Load Meter	×				11111	Ш	
						Ш.	44
				444	41111		
Engine Fire	x	x x x x x		x	11114		-111
flt Path Stab Sys Fall	×	[x x xx x	xxxxxx	x	x	x	Щ
Stabilator Auto Mode In Op	x	X X X X	x x x x x x	x			Ш
Stabilator Position	x	x x x x x	xxxxxx	×	x		111
				1111		Ш	44
					ШШ		Ш
SAS Off		x x x x x	x x x x x	<u> </u> ×	×	x	\bot
			_				Щ.
			_			1111	444
Pitch Bias Failure	x	XXXXX	X X X XXX			<u> </u>	111
							444
			_	1111		1111	-111
Gust Lock Mot Disengaged	<u>×</u>	××××	x xxxxx	1111	×	×	Ш
					_	<u> </u>	411
					<u> </u>		444
IFF In Operal Eve	- x - -		X XX X X		11 11	4 <u> </u>	111

TABLE 21. CONTINUED.

PARAMETER	PRIORITIES	MISSION PHASE	ENV I ROMMENT	DISPLAY	FORMAT	RE- PONSE	FEED- BACK
	ATTENDED TO THE PROPERTY OF TH	TAKEOFF CRUISE KOVEŘ LAMO SMÝTDOM	MIGHT DAY VAC 1 PC NOT ATTION	CONTINUAL CRITICAL ORLY ACCESS ORLY	GUARTTRATIVE GUALITATIVE COMINED COMINGO	AUTO DESTINALE AUTO NOT DESTINALE	DISPLAY UNICESSARY
Eng. Anti-Ice On	K	xxxxx	MX X MX X	x		d I Ix	
						1111	111
			<u> </u>	1111		<u> </u>	4
Pitot Heat On	X	X X XXX	x x x x x	1 4 1	1111	(! x	
		_!!!!!!			-11111	1111	-11
		_!				1111	411
Heater On		_!!!!!		1111		1111	Щ
Heater Not	x	x x x x	x x x x xx	X			111
	!_! _				-44144	Ш	444
			_]]]]]]]	1111		\coprod	
Cargo Hook Open		x x x xx	× ××××	X		444	111
Cargo Hook Armed	<u> </u>	x x x x x	x x x x x x				$\perp \downarrow \downarrow \downarrow$
			_ _ _	444	4444	\coprod	
		_111111				\coprod	
Parking Brake (In		× × × ×	× × × ×××	×			$\perp \downarrow \downarrow \downarrow$
				4444		1111	-111
		_111111				Ш	
Eng. Start Valve Open	X	AIII	* * * * * *		$\perp \parallel \parallel \parallel$	× ×	Щ
						1111	Щ
	X	× × × ×	_ xkk xkk	777		×	

TABLE 21. CONTINUED.

Additional Areas

4

Please answer the following questions:

Can you think of any other items of subsystem information that should be displayed in future helicopters?

Rate of change data during limit approach or excedance.

Which caution/warning lights have you found illuminate most frequently? How frequently? During what conditions?

Chip Detectors

 $\label{problems} \mbox{FPS/stabilator - due to SAS/FPS computer problems shutting system down} \\ \mbox{Electrical system}$

Are there any caution/warning lights that you have found to be unreliable?
Chip detectors
Fire warning

TABLE 21. CONTINUED.

What aspects of subsystem monitoring have you found to be most problematic, annoying, or distracting during NOE flight?

How do you feel about presenting information through voice warning systems or through beeps, tones, etc.?

Mixed reactions, from: "noise distracting" to "love it".

What problems do you see arising with systems that require you to push buttons to obtain information about subsystems?

TABLE 22. CH-47C PILOT CONSENSUS.

PARAMETER	PRIORITIES	MISSION PHASE	ENVIRONMENT	DISPLAY	FORMAT	RE- PONSE	PACK PACK
	SAFETY HISSION NATIFEMAC UNINECESSARY	TAKEOFF - CRUISE - HOVER - LAW SAUTUGRR	BIGHT BAY WRC INC NOC ALTITUDE	CONTINUAL CRITICAL DRLY ACCESS ONLY	QUANTITATIVE QUALITATIVE CORINED CAUTION ANTICON	AUTO DESTRABLE AUTO NOT DESTRABLE	DISPLAY UNICCESSARY
Fuel Quantity	×	xxxx	* * * * * *	×	×	x	
fuel Low	x	xxxx	k x x x x x			l k	Π
Fuel Pressure	×						1
Fuel Pressure Low	x ·	x x xx x	xx x x xx	×		11	!
Fuel Filter Obstructed	×						•
Prime Boost Pump On							
Fuel Boost Pressure Low	x	x x x xx	x x x x x	x		_x	
							Ш
						Ш	111
Engine Oil Temperature		× × × ×	×××××	x			
Engine Oil Temperature High	×	×××××	x	x j	×	,	Ш
Engine Oil Pressure		k k k k	× × × × ×		×	×	Ш
Engine 011 Pressure tow	×	x x x x	x x x xx x			x	Ш
Engine Oil Quantity	x		111111	1111		\coprod	111
Engine Oil Quantity Low	x	x x x x x	×××××				111
Oil Filter Bypass	x			$\bot \downarrow \downarrow \downarrow$	41111	\coprod	111
Engine Chip	x	X X X X	_ <u>x xx x</u> k <u>x</u>				Ш
				<u> </u>	<u> </u>	1111	111
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TABLE 22. CONTINUED.

PARMETER	PRIO	RITIES	MISSIO	M PHASE	ENV TROPPLENT	DISPLAY	FORMAT	RE- PONSE	FEED- DACK
	SAFETY	UNICESSARY	TAKEDFF	MOVER LAND SKATDORN	ANSAT. ANSAT. ANY INC. INC. ALTITUDE	CONTINUAL CRITICAL ONLY ACCESS ONLY	QUANTITATIVE QUALITATIVE CONSINED CANTION	AUTO DESTRUBLE	DISPLAY UNRECESSARY
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EGT	×	Π	k k	×××	×××××				J
H _p		×							
Inlet Air Pressure Megative		×				1111	Щ	1111	
					111111	1111	ЩЦ	111	Ш
						1111	11111	111	111
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Engine Out	×	Ш_	××	×××	×××××	141	11114	114	444
N ₁ Control Loop Energized		<u> </u>			444444	1111		\coprod	444
	$\perp \! \! \! \! \! \perp \! \! \! \! \! \! \! \! \! \! \! \! \!$					1111	11111	\prod	Щ
	11	Ш_			111111	1111	11111	\prod	411
XMSN 011 Pressure	<u> </u>		_ x x	x xx	XXXXXX		1141	1111	111
XMSN 011 Pressure Low	<u> </u>	Ш_	<u> </u>	× ××	XXXXX		11114	1141	111
XMSN Oil Temperature	x	111_	<u> </u>	XXX_	XXXXXX		11111		111
XMSN 011 Temperature High	×	111_	k k	X X X	×××××	1111	11111	\coprod	111
Chip Hain XHSH NA]]]_			_	444	11111	\mathbf{H}	111
Chip Int XMSH NA				<u> </u>				Ш	Ш
Chip Tall XMSN NA	_[_]	111_					11111	\coprod	111
XMSN Oil Bypass		<u> </u>	_ _		_	_1_1_1	<u> </u>		44
		111		1111		.1111.		Ш	111

TABLE 22. CONTINUED.

PARAMETER	Pf	RIO	RI	71	ES	MI	SSI	Q)	• •	HIA:	SE	EN	Ň	RO	101	EN	T		•) I S	PL	AY		FO		M	r .		P	E - Cov	SE			FE(ACI	
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Main Rotor Overspeed	,	1	Ī	Ī		k	k	×	1	d×		×	ļ	k	k	ļ	٩×	Ī			x					. *			T		X		Ī		
Low Rotor RPM	Ī×	1	T	T		k	k	×	4	¢χ		×	ķ	k	k	ķ	ķ	I			x					×			I		X		i		
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Primary Servo Pressure Low NA	\perp	L					1	1	1	L		l	l	ļ	1	l	1	l				\downarrow		Ц		Ш	Ц	Ц					1	ļ	L
Hydraulic Pump Pressure Low	×					ŀ	ŀ	d	φ	Ŀ	<u> </u>	k	ļ	4	ŀ	d.	d	Ł			X					×					X		l	L	L
Primary Servo Jam NA	I	I					1	Ţ						1	1		1					Ц					Ц	Ц	Ц				1	1	L
Boost Servo Jam NA	I	I					1						l		1		1			L					L	L			Ц				1	ļ	L
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Tail Rotor Servo Pressure Low NA				l	<u> </u>		1]	1	1	<u> </u>	l	l	1	1		1	1				Ц			Ц		Ц	Ц	Ц		Ц		1	1	L
Backup Pump On NA	1		L			1	_	1	1	ļ	<u> </u>	<u> </u>	1		ļ	1	1	1		L	L	Ц		L		L	Ц	Ц	Ц		Ц		1	ļ	ļ
Flight Control Hydraulic Pressure	×	4				,	4	×Į.	×.	(x		ŀ	1	×	4	4	4	4			×			L	Ц	X		Ц	Ц		×	_	1	ļ	L
Utility Hydraulic Pressure	ļ×	4	L			ļ	<u> </u>	4	×.	(x		ļ	1	×	þ	4	×	ł		_	×	Ц.			Ц	X	Ц	Ц	Ц		×		1	ļ	ļ
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TABLE 22. CONTINUED.

PARAMETER		'R	OR	111	ES	M	SS	10	n 1	PIU	\S E	EN	۷i	ROI	ø	EØS	ı		P	SP	ŁA	Y	F	OF	MA	ī			NE PO	MS	E		FE	/CK ED	•
		E S	MISSION	INVESTIGATION OF THE PROPERTY			TAKEOFF	Sing.	MOVER	Circumon Contraction	STO : COMIN	Mier	À	¥	¥	¥06	A TITUDE		PROCESSIAL STATES	A MALE MALE	ACCESS DATA		A STATE OF THE	City Charles	COMP INC.	Carrie	ANI SORV		ALTO DESTRABLE	THE PERSON OF TH			DISPLAY	DISPLAY UNNECESSARY	
APU Exhaust Temperature High	- 1	x	1	1		- 1	×		1	,	1	×	Ī,	k	×	×	×	Г	Ţ	ï			Ī	I	Ī	Į,	J		Ī	Į,	I		I		
APU 011 Pressure Low	T	×					×			ŀ	4	×	ŀ	×	×	ŀ	×		brack I	I	1		I		I	ŀ	1			I	\mathbf{I}		-	\prod	
APU Overspeed		4	I	I			X			k	I	×	Ŀ	k	×	×	×		I	ŀ	1		I	1	I	ŀ	1		[k			ļ		
APU Underspeed		4	1				ĸ		1	k		×	Ŀ	ŀ	×	×	×			ŀ	d				ĺ	ŀ	1		1	6			1		
APU Sequence Fail		4					×			k		×	Ŀ	Į,	×	×	×		1	1	1	_	1		ĺ	ŀ	1	l	į	1	1		:	Ц	l
APU Fire		7		I		_[X			k		x	×	,	×	×	k			ļ	d	1	1			ļ	1	ł	1	Ĺ	1		1		l
APU Generator On				ļ								ľ						L			l	1						l	l	1	1	_			L
APU On			×			_}	X			ŀ	9	×	ŀ	ŀ	ŀ	ŀ	×		I		×		1		l	Þ	1		l	ļ					
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Battery Fault	[×					×	X	×	×	×	 ×	Į,	4	*	i	ķ			1	×		1			k				1	1		1		
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TABLE 22. CONTINUED.

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		SLETY	HISSION	MAINTENANCE	UNNECESSARY		TAKEUPP	CRUISE	MOVER .	980	SHUTUORN	KISIT	DAY	YE	T.	3ON	ALTITUDE.	SOUTHERN	CRITICAL DREY				CUANTITATIVE	OUAL ITATIVE	CONGINED		250	AITTO DECTRARIE	THE PERSON I	Manufold Inches		DISPLAY	DISPLAY UNHECESSARY	
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DC Load Heter		T			×	I													L							1	L	l	I					
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Engine Fire		×				 ļ	ĸ	X	× į	ď	×	 ×	×	×	X	X	X	L	×							×	1	l	Ī	4		1		L
Fit Path Stab Sys Fall	NA	T			T	 1			Ì										L						I	1	l	Ĺ	Ĺ	l			L	L
Stabilator Auto Mode in Op	NA	Τ	П		1	i	T	T	Ī	T	T		Г	Г											Ī	I	I		Ī	I				
Stabilator Position	NA		П			Ì	I	I	I	I									I	ľ						\mathbf{I}	1	I	I	I				
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TABLE 22. CONTINUED.

PRIORITIES	HISSION PHASE	ENVIRONMENT	DISPLAY	FORMAT	RE- FE PONSE BA
SAFTY MISSION WINTERANCE UNIVERSISARY	TAKEDF CRUISE HAVE SHOTOGHN	AT GAT SAY YNC YNC NO E ALTITUDE	CONTINUAL CRITICAL ORLY ACCESS ONLY	OUANTTI ATTVE CUM, ITATTVE CUM, INED CAMTON	AUTO DESTRABLE AUTO NOT DESTRABLE DISPLAY
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<u> </u>	x x x x	××××××	_ x _	<u> </u>	
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			444	-11!11	
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┼ <i>┼</i> ┼┼	-+++++-	╼╂┨┩╂╂╃╂		╌╂╀╂╂	╂╂╂╌╂
	╼╣╃╃╂╬╌	╌ ┨╌╂╶╂╌╂╌╏╴	444-	-1-1-1-1	┨╁╁╂┷┹╴
	X X X X X X X X X X X X X X X X X X X	X		X	

TABLE 22. CONTINUED.

Additional Areas

Please answer the following questions:

Can you think of any other items of subsystem information that should be displayed in future helicopters?

V_{NE}: Approaching or exceed

Speed trim not extending/retracting with change in airspeed

Fuel flow meters

Digital readout for weight on hook

Which caution/warning lights have you found illuminate most frequently? How frequently? During what conditions?

Chip detector (engine)

Wheel dephased

Are there any caution/warming lights that you have found to be unreliable?

Engine chip

XMSN chip

fire handle

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TABLE 22. CONTINUED.

What aspects of subsystem monitoring have you found to be most problematic, annoying, or distracting during NOE flight?

Monitoring engine indications not backed up by caution lights

How do you feel about presenting information through voice warning systems or through beeps, tones, etc.?

Excellent, so long as they don't interfere with communications, and so long as beeps/tones are not confused with other aircraft sounds.

Problematic where sensors are unreliable.

Should allow for re-set turnoff.

What problems do you see arising with systems that require you to push buttons to obtain information about subsystems?

Recommend cyclic/thrust locations.

The state of

TABLE 23. OH-58C PILOT CONSENSUS.

PARAMETER	PRIORITIES	MISSION PHASE	ENVIRONMENT	DISPLAY	FORMAT	RE- FEED- PONSE BACK
	SAFETY HISSION HANTERANCE UMECESSARY	TAKEOFF - CRUISE - HOVER - LAND SHUTDOWN	BIGHT DAY VMC INC NOE ALTITUDE	CONTINUAL CRITICAL DALY ACCESS ONLY	QUANTITATIVE QUALITATIVE COMBINED CANTON ANISORY	AUTO DESTRABLE AUTO NOT DESTRABLE DISPLAY UNIECESSAÁY
Fuel Quantity	×	x x	xx x xxx		k k k	
Fuel low	×	x x x	xxxxxx	k		l k
fuel Pressure	x	x x	x x			k k
Fuel Pressure Low	x	X X X X	x xx xx x	×	x x	x x
Fuel Filter Obstructed	×	x x x x	x	×	x x	k k
Prime Boost Pump On		x	××××	×	×	
Fuel Boost Pressure Low		k x x x	x	x !	x	
			111111			
Engine D11 Temperature					_ x	x x
Engine Oll Temperature High	x	XXXXX	* * * * * *	k	×	x x
Engine Oil Pressure	×				<u> </u>	
Engine Oil Pressure tow	x	X X X X	x x x x x	l x		
Engine DIT Quantity	×					
Figine Oil Quantity Low	×	×××××	× × × × × ×	×		
Oll Filter Hypass	×	x x x x x	× × ×× ×	x	×	
Engine Chip	×	x x x x x	×××××	×) ×	x

TABLE 23. CONTINUED.

PARAMETER	PRIORITIE	S MISSION PHASE	ENVERONMENT	DISPLAY	FORMAT	RE- PONSE	FEED-
	SAFETY HISSION HAINTENANCE UNNECESSARY	TAKEOFF CRAISE HOVEN LAND SHUTDAN	NIGHT DAY VMC INC NOE ALTITOE	CONTINUAL CRITICAL DALY ACCESS ONLY	QUANTITATIVE QUALITATIVE COMBINED CANTION	AUTO DESTRABLE AUTO NOT DESTRABLE	DISPLAY UMECESSARY
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EGI					71111		Π
N _p							
Inlet Air Pressure Megative							-
							i
H _g							
Engine Out	×	x x x x x	xxxxx	×	×	x	×
N ₁ Control Loop Energized							
				1111	<u> </u>		111
XHSN 017 Pressure			 		11111	-	-
XMSN 011 Pressure Low	- x - ^	× × × ×	× × × × ×	^ -	X X	x	×
XMSN 011 Temperature			- -		X X	 	- x
XMSN 011 Temperature High	×	xx x xx	x x x x x	×	x x	x	×
Chilp Main XMSN	×	xx x xx	x x x x x	×	111x	x	×
Chip Int XMSH	×	x xx xx	x x x x x x	<u> </u>	11 ×	T x T	×
Chip Tall XMSH	×	X XX X X	× × × × ×	111	111×1	1 x 1	×
XMSN Off Bypass	×	× ×× ×	X X X X X		T	×	×
	11111						

TABLE 23. CONTINUED.

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	CAESTV	MISSION	MAINTENANCE	UNNECESSARY		TAKEOFF	PRITSE	Tuwes		SAUTOON			MIGHT	DAY	3	IMC	302	ALTITUDE			CONTINUAL	CKITICAL UNIT	ACCESS ONL!		QUANTITATIVE	COMPLITATIVE	Compliance	A001.00	Tune I	AUTH DESTRARIS	THE STATE OF THE S			DISPLAY	DISPLAT UNITELESSORY
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Main Rotor Overspeed	×	×	Ī			×	×	ŀ	4	×			X	x	×	x	F	x	Г	T	1	×	Τ			ŀ	Ī	Ī	Γ	x		Γ	1	×	
Law Rotor RPM	×	T	Γ	Ī		×	×	ļ	ķ	×	1		×	x	×	x	ľ	×	Γ	1		×	Τ	1	1	1	J	T	Γ	k	Ţ	Π	i	x	T
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Primary Servo Pressure Low	×	T	Ī	Ī		x	×	ļ	d×	×	Γ		x	x	ķ	×	×	×	Γ	T	1	x	T	Ī	1	I	1	x	Ī	k	Ī	T		x	I
Hydraulic Pump Pressure Low	×	Ī	ľ	Γ		×	Ī×	,	þ	ķ	,		X	x	k	×	×	x	Γ	Ī	1	x	T	Ī	Ī	T	Ţ	x	Ι	ķ	T	Γ		×	T
Primary Servo Jam	×	T	T	T		×	×	ļ,	d,	,			x	x	ķ	×	ķ	Ī,	╏	1	1	x	T	1		Ť	1	x	T	Ī	Ī	T		x	Ī
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Boost Servo Pressure Low	×	T	Ī	ľ	<u> </u>	×	×	ļ	4	×	Γ		X	x	k	×	×	ķ	Ī	1	7	x		Ī	Ī	Ţ	1	×	Ī	k	T	T	٦	×	T
Tall Rotor Servo Pressure Low	×	T	Ī	ľ		×	×	ļ	4	k	Γ		x	x	ķ	×	×	×	Γ	Ī	1	x		1	1	Ţ	Ţ	×	Ī	k	Ī	Γ		×	T
Backup Pump On	×	Ţ		Ī		×	×	Ī,	, 	ķ	,		x	х	,	×	×	k			1	x	Ţ			T	1	χĪ	Ī	k	Ī	T		×	Ţ
flight Control Hydraulic Pressure	T	T	×	Ī		×	×	Ī,	Ţ	k	Τ		×	x	ļ,	×	×	ķ	Γ	Ī			x	1	1	Ī	Ī	k	Γ	Γ	K	Γ		x	I
Utility Hydraulic Pressure	T	1	×	٦	[×	×	ļ	ķ	k	1		x	x	ļ	×	×	×	Ī	1	1	1	x	1	1	T	Ī	k	T	Ī	ŀ	T	7	×	T
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TABLE 23. CONTINUED.

PARAMETER	PJ	10	t I 1	IES	111	SS	10	*	PI	IAS	E (EN	41	RO		Œ	NT		 DĮ	SP	LA	¥		FI		1A	ľ	_	_	R	E-	SE	:			KCK	
	CLESTY	MISSION	MAINTENANCE	UMPECESSARY	Parener		LAU130	MOVER	LAVO	SHUTDOWN		MICHT	DAY				MOE.	ALTITUDE.	CONT. THIAL	PIEC INTERIOR	ACCES ONLY			CUANTITATIVE	OUALITATIVE	COMBINED	CAUTION	Amvigony	The same		AUTO DESTRABLE	AUTO NOT DESTRABLE			DISPLAY	DISPLAY UNKECESSARY	
APU Exhaust Temperature High	×	П			Tx		1			×			×	Т	I	I	I		Ī	k	Т					x		ľ	I		x				x		
APU 011 Pressure Low	×				Tx	I	1	Į		×		X	×	Ī	I	I	I			k						×		I	I	-	×			_	k		Ĺ
APU Overspeed	×	П			x					X		x	×	I		I				k	I					×		I	I		X		Ĺ	_	lx		
APU Underspeed	Ι	x.			×			1	X	×		X	k	I						k	I				L	Ĺ	k		l	1	X				¦x		
APU Sequence Fail	Ι	x			×				X	x		x	k	I	I					ķ	I	I		L		L	Ļ	Į	l	į	x	1	L		; X		
APU Fire	x				ļ×		ĸ	X	X	x		X	ļ	ŀ	ŀ	d	×	x		k		Ī		L	L	L	Ŀ	1	1		X	Ĺ			k	L	l
APU Generator On		x			lx	,	ď	x	X	×		X	×	k			X	x		I	ķ	1			Ĺ		L	ļ				,			k		
APU (în		×			x],	,	x	X	X		X	×	I	k		×	x		I	k							ļ	1			×			L	L	l
'APU Tachometer				x	Ī														Ī	I						L							L	_		L	Ĺ
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Generator Output	I			x																I								l	l				L		L		Ĺ
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Converter Output Low		×			ķ			x	X	x		×	ı	1	1	1		X		ļ					L		k	1	1		X.	L	L		k	L	l
Rectifier Off		×			k			X	X	x		×	×	Ų.		X	X	X			ل		_			L	k]]		X.						
Battery Low Charge			×		,	1				×		Ł	×	1		_[_	Į.		1	d		L	L		L	ŀ	1		X	L			k		
Battery Fault	×				þ	ŀ	×	×	X	×		×	×	ŀ	4	×	k	x		ŀ	1					L	×	l			×		L		k	L	L
AC ESS Bus Off		×			ļ		×	×	x	×		×		×	·	x	×	×		Ţ	·[k	I	I		k.				Į,		Ĺ
DC Ess Bus Off		×			×		×	×	×	×		×	ļ	d	×	×	x	k		ļ	J				L	<u> </u>	k	Į.			k.	L	L		Į,	L	

TABLE 23. CONTINUED.

PARAMETER	PRIORITIES	MISSION PHASE	ENV I NONMENT	DISPLAY	FORMAT	RE- FEED- PONSE BACK
	SAFETY MISSION MAINTENANCE UNNECESSARY	TAKEOFF CRUISE HOVER LAND SKUTDORN	MICHT DAY DAY DAY DAY DAY DAY DAY DAY DAY DAY	CONTINUAL CRITICAL DALY ACCESS ONLY	QUANTITATIVE QUALITATIVE CONSINCO CONSINCO ADVISORY	AUTO DESTRABLE AUTO DESTRABLE DISPLAY UNIVERSSARY
AC Load Meter	×					
DC Load Heter	x					
Engine fire	x	x x x x	xx x xx x	k		x x
Fit Path Stab Sys Fail	x	[x x x	x xx x x	k	k	xi k
Stabilator Auto Mode In Op	x	j× x x x	x	×		
Stabilator Position	x	x x	k	×	$\prod \prod_{k}$	x x
					11111	
SAS OFF	×	XXXXX	XXXXX	x		x x
		_				
Pitch Bias Failure	x	x x	x x x x	×	x	x x
				1111		
			_	4444	11111	
Gust Lock Not Disengaged					ШШ	
					4444	<u> </u>
and the state of the same the	_			<u> </u>	1111	
IFF In Operative			111111			1111 111

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TABLE 23. CONTINUED.

PARMETER	PRIGRITIES	MISSION PHÁSE	ENVIRONMENT	DISPLAY	FORMAT POR	FEEB-
	SAFTY NATIVE BANKE IMPROFESSION	TACOFE CRISS CRISS LAND SATTOGRA	ATTION ATTIONS	CONTINUAL CRITICAL DRLY ACCESS ORLY	QUANTTATIVE QUALTATIVE CONSINED CAUTION ADVISORY AUTO DESTANSE	AUTO NOT DESTRAINED
Eng. Anti-Ice On	1 x	x x x x	x x x	x	\mathbf{H}	x x
Pitot Heat On		x x x xx	x x x			
_						
fluter On			1111111	TITE		
Heater Hot	×	k xxxx	×××××	×	×	
						
			1111111	TIII		
Caryo Houk Open		××××	K X X X X X	1111		
Cargo Hunk Armed	×	XXXX	k k x x k k	TIL	THILL	
				7111		
		_17177		7777		ППП

TABLE 23. CONTINUED.

Additional Areas

Please answer the following questions:

Can you think of any other items of subsystem information that should be displayed in future helicopters?

- 1. A system to inform the pilot where hits were scored on his A/C while in a combat environment. Damage report if you will.
- 2. Some type of load measure to inform the pilot of the weight he is about to pick up.

- An indication of the presence of ice on the blades.
 An indication of a door that is not secure.
 A sequence light for starting procedure and shutdown procedure, if proper sequence is not followed light comes on.
 Display of the proper emergency procedure to accompany the caution light or audio instructions to each the pilot and copilot as to their proper actions.
- 7. Fuel management system

Which caution/warning lights have you found illuminate most frequently? How frequently? During what conditions?

Eng. Fire - The frequency depends on the A/C - Usually during runup Chip Lgt. -- Varied Rec. Lgt. -- Usually during runup

Are there any caution/warming lights that you have found to be unreliable?

Unfortunately, the chip lights usually are unreliable.

TABLE 23. CONTINUED.

What aspects of subsystem monitoring have you found to be most problematic, annoying, or distracting during NOE flight?

I am not qualified to respond as to NOE however using similar techniques in civilian work I found gauges in general to be annoying and difficult to read.

How do you feel about presenting information through voice warning systems or through beeps, tones, etc.?

GREAT---provided: audio systems should present the information in much the same manner as a copilot would. i.e., a tone to inform you a message is coming then a brief, concise description of the problem.

What problems do you see arising with systems that require you to push buttons to obtain information about subsystems?

Without a copilot to assist you alot! With a copilot very little if any examples: control while hand and eye are pushing buttons, errors in pushing the right buttons.

TABLE 24. AH-1G PILOT CONSENSUS.

-4

PARIMETER	PRIORITIES	MISSION PHASE	ENVIRONMENT	DISPLAY	FORMAT	RE- PONSE	BACK PACK
	SAFETY MISSION MAINTENANCE UNNECESSARY	TAKEOFF - CRUISE HOVER - LAND SKUTEGEN	MI GAT DAY VMC 114C M TTTUDE	CONTINUAL CRITICAL ORLY ACCESS ONLY	OUANTITATIVE QUALITATIVE CORSINED CAUTION AVIENDA	AUTO DESTRABLE AUTO NOT DESTRABLE	DISPLAY DISPLAY UNITETESAKY
fuel Quantity	×	x x x x	x x x x x	x	x		Π
Fuel Low	×	x x x x	x xx x xx	×	$ \cdot _{x} $		Ш
Fuel Pressure	×	xxxx	x x x x x	×	×		
Fuel Pressure Low	×	x x x x	x x x x x x	x	×	x	!
Fuel filter Obstructed	×	x x x x	x x x x xx	x	×	k	!x
Frime Boost Pump On	_						
Fuel Boost Pressure Low	X				11111		111
					<u> </u>		Ш
						\coprod	111
Engine Oil Temperature	_ k	x	×××××	_ _x			Ш
Engine Oil Temperature Hig.		x x x x x	× ××× ×	× j	×		Ш
Engine 011 Pressure	×	x x x x x	x x x x x	×	x		Ш
Engine Oil Pressure Law	×	x x x x x	x	×	,×		Ш
Engine Oil Quantity	×			Ш			Ш
Engine Dil Quantity Low	×	x x x x	x x x x x	×	×		Ш
Oll filter Bypass	×	x xx x x	×××××	×		×	x
Engine Chip	x	x xxx x	x x x x x x			x	\coprod
							Ш
							\prod
							111

TABLE 24. CONTINUED.

PARAMETER	PRIORITIES	MISSION PHASE	ENVIRONMENT	DISPLAY	FORMAT	RE- PONSE	FEED- BACK
	SAPETY MISSION THE TOTAL THE TENENTY THE THE TENENTY THE THE TENENTY THE THE TENENTY THE TENENTY THE TENENTY THE TENENTY THE TENENTY THE T	TAKEOFF CRISS CRISS LAVER LAVER SAUTDOM	MIGHT NA. INC. ALTING	CONTINUAL CRITICAL ONLY ACESS ONLY	GUANTITATIVE QUALITATIVE COMBINED COMBINED ANY SON	AUTO NOT DESTRABLE	DISPLAY UNNECESSARY
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ECI	×III	x x x x	× × ××	1,111	11111	l x	\prod
N _p			1111111		11111	1111	
Inlet Air Pressure Hegative				1111	11111	liil	:11
			7111111	1111	11111	111	
			TIIIII	1111	$\Pi\Pi$	11.1	711
N _g			1111111	1111	11111	liil	$\dagger \dagger \dagger$
Engine Out	×	×××××	×××××	111	11111	titt	†††
N ₁ Control Loop Energized	×		1111111	$\Pi\Pi$	71111	Hft	111
				TIII	11111		111
			111111	1111	1111 1		†††
XHSN 011 Pressure	×	× ×× ×	×××××	x	1111		† †
XMSN 011 Pressure Low	×	××××	× × × ×× ×	121	11111		##
XMSN 01) Temperature	×	×××××	× × × × ×		1111		##
JMSN 011 Temperature High	x	×××××	× × × × ×				† †
Chip Main XMSN	×	XXXXX	×× × × ×				†††
Chip Int XMSN	×	×××××	XXXXXX	T[111[]		
Chip Tail XMSM	×	X X X X X	XXXXXX	1[-	111[1		
XMSN OIT Bypass		XXXXX	X XX XX X	- -			
					T -	<u> </u>	f t

TABLE 24. CONTINUED.

PARAMETER	PI	110	RI	TI	ES I	415	51	OI	1	M	ASE	ER	IV I	RO		EN	IT		ı	DIS	PL	.At	,		ror	W	ıT			R	E -	SE			FEE	
	SELLA COLONIA	MISSION	MAINTENANCE	UNNECESSARY		TAVEREE	1000	Towne	L L		SHUTDOM	KICKE		250	THE COLUMN TWO IS NOT THE COLUMN TWO IS NOT		A TTHINE		. !	CONTINUAL	CRITICAL DRICY	ACCESS ONLY			CUMMITTATIVE	WALL IN LYE	The later	CAUTION	TIME TO		AUTO DESTRABLE	AUTO NOT DESTRABLE			DISPLAY	DISPLAT UNRECESSART
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Main Rotor Overspeed	×			П		ķ	×	ŀ	1	×	T	 k	×	ļ	×	k	,	4			×					,	ĸ	Ì		1	×			1	×	
Low Rotor RPM	×	Γ				×	×	ŀ	Ī	×	Ţ	K	k	ļ	×	k	,	4			k					ŀ	ĸ			Ţ	X		Ĺ	i	X	I
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	T					Ī		I			floor		I	I	I	I	I	I					Ĺ		1				1	\prod						
Primary Servo Pressure Low		Γ					I		I				L	I						L	L	L				1		1					L		Ц	1
Hydraulic Pump Pressure Low	×					×	×		×	×	×	×	ķ	ŀ	k	ŀ	d,	ď			×			1		ŀ	d	1	1	1		X	L		Ц	\perp
Primary Servo Jam	Ι	I		×		L														L			L			1		_	1	1			L		Ц	1
Boost Servo Jam	L	L	L	×		L		l												L					1	1	1		_	1		Ц	L		Ц	
Boost Servo Pressure Low				×		L							L	l	1					L	L			1	1	1	1	1	1			Ц	L			1
Tail Rotor Servo Pressure Low	L		L	×	i								L		1	1				L	L				1	1]	1	1	1		Ц	L		Ц	╧
Backup Pump On		L	L	×		L	1	1	1		_[L	1	1	1	1	1	1	_	L		L	L	1	1	1	1	1	1	1		Ц	L		Ц	1
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TABLE 24. CONTINUED.

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		Skery	MISSION	PAJR TENANCE	UMMELE SPAKE		TAKEOFF	CRUISE	HOVER	LAND	SHUTDOWN		wited	P	¥	, K	304	ALTITUDE.		CONCTINUAL	CRITICAL DRLY	ACCESS ONLY			CUANTITATIVE	GUALITATIVE	CONSTRED	ADVISORY		AUTO DESTRABLE	AUTO NOT DESTRABLE	DESPLAY	DISPLAY UNRECESSARY
APU Exhaust Temperature High	NA															L					L						Ī						
APU 011 Pressure Low	NA													Ĺ														I					
APU Overspeed	ŅA														I						L					1		1					
APU Underspeed	NA							L												L						1		I					
APU Sequence Fail	NA							L													L							1				;	
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DC Ess Bus Off			×				×	X	k	x	X		ŀ		×þ		k	×			k						_	4		Į.			

TABLE 24. CONTINUED.

PARMETER		PE	10	RI	ILE	:S	MIS	SSI	ON	I P	HA:	SE	EI	WI	RO	181	EN	T		DI	SP	LAY	!		FO	a	AI			•	E-	SE			FEE	8 -
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DC Load Meter				X			×	Į,	,	×	×		ļ	,	ķ	×	ļ	×		I	×						X		\prod			X	L	Ī		I
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TABLE 24. CONTINUED.

PARAMETER	PRIORITIES	HISSION PHASE	ENVIRONMENT	DISPLAY	FORMAT	RE- FEED- POISE BACK
	3,0277 H. 551 OH H. 1,17 EVANE	TAKEDF PRUSSE LAND SHOTDORN	JATEST DAY DAY INC INC AUTITUSE	CONTINUAL CRITICAL DRLY ACCESS ONLY	QUANTITATIVE CUALITATIVE COMBINED CANTION	AUTO DESTABLLE AUTO DESTABLLE DESPLAY DESPLAY UNIVEEESSARY
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Pitot Heat On	×	x x x x	xxxxxx	×	1111	4! x
		_!!!!!	111111	1111	41441	
	11111		ШШ	1111	11111	
Heater On			ШШ	1111	11111	
Heater Not			<u> </u>			<u> </u>
			111111	444	4444	1111-111
		_111111		1111	11111	
Cargo Hook Open	×	XXXXX	x x x x x	X	$\perp \sqcup \sqcup \sqcup$	41 X
Caryo Hook Armed	×	XXXXX	XXXXX	×	1111	<u> </u>
			_	1111	4444	1111-111
				444	4444	
Parking Brake On	X		_ _ _	444	4444	
				444	-11111	1111-111
				Щ	11111	1111-111
Eng. Start Valve Open						
Master Caution	<u> </u>	_ x xxxx	XXXXXX	121	<u> </u>	
	11111	11111	-	1111		1111_111

TABLE 24. CONTINUED.

Additional Areas

Please answer the following questions:

Can you think of any other items of subsystem information that should be displayed in future helicopters?

A/S below effective translational lift. Mast movement indicator on rigid rotors.

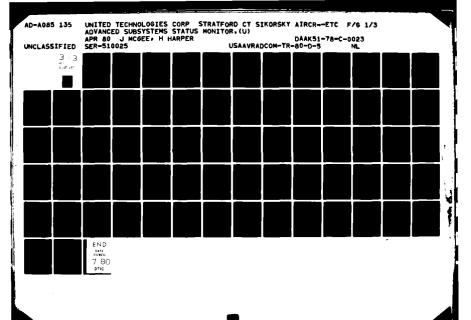
Which caution/warning lights have you found illuminate most frequently? How frequently? During what conditions?

Aux. Fuel Low
RPM High
Engine Chip
Fire Warning Light (UH-1H)
Fuel Boost Pumps During Cruise
Tail Rotor Chip
DC Gen. - at low RPM after autorotation
Hydraulics Off

Are there any caution/warning lights that you have found to be unreliable?

At times hydraulic pressure warning will not illuminate for several seconds after system is inoperative. (UH-1) $\,$

20 min. fuel light Fire Warning (UH-1H) Hydraulics Off



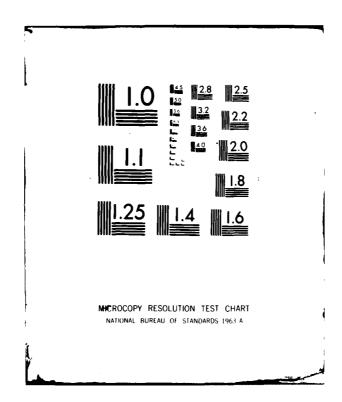


TABLE 24. CONTINUED.

What aspects of subsystem monitoring have you found to be most problematic, annoying, or distracting during NOE flight?

Eng./XMSN instruments in new A/C.
#. %, tic marks difficult and time consuming to interpret.
Electrical system monitoring

How do you feel about presenting information through voice warning systems or through beeps, tones, etc.?

Excellent, especially as backup.

Recommend visual backup.

Washout problem possible.

Recommend incorporation of procedural info.

Recommend preceding tone to message.

What problems do you see arising with systems that require you to push buttons to obtain information about subsystems?

Possible confusion

System failure?

Reaction - actuation delay

TABLE 25. HELICOPTER X MISSION PHASE MATRIX.

Engly State Color Fresh Low Fig. 11 Towns High Engl					\$	H-60A				8	CH-47C	١			İ	GH-58C	ايوا					AH-16		
Fuel Quantity Fuel Low Fuel Low Fuel Low Fuel Pressure Fuel Pressure Fuel Pressure Fuel Pressure Fuel Prize Boost Press Low Fuel Fuel Fuel Fuel Fuel Fuel Fuel Fuel	SUBSYSTEM	PARAMETER	T204/384	TAKE-OFF		HONER		1204\394 NW0GTUH2			<u> </u>			1204/384		CENTSE	HOVER		TZOT/3M4	TZO4/394				
Fuel low Fuel low Fuel low Fuel low Fuel low Fuel Pressure Low C C C C C C C C C C C C C C C C C C C	Engine Fuel	Fuel Quantity	-	'	-	-	•	_	_		_	· _	-	-	•	-	-	٠	_	_		_	·	_
Fuel Pressure Fuel Prissure Low Fuel Prissure Low Fuel Prissure Low Fuel Prissure Low Fuel Prissure Low Fuel Prissure Low Fuel Boost Pump On Fuel		Fuel Low	J	U	J	Ç	J	٠	ပ	U					Ų.	U	v	u	S	U	J	_	_	
Fivel Pressure Low C C C C C C C C C C C C C C C C C C C		Fuel Pressure																			,	_		
Fuel Filter Obstruct/Bybass C C C C C C C C C C C C C C C C C C		Fuel Pressure Low	J	_	U	U	U	J	U											Ų	J			
Friee Boost Pump On A		Fuel Filter Obstruct/Bypess	J	_		U	ပ	J						J	U	ü	ပ	U	u	ں	J	_	_	
Fig. 011 Tamperature 1		Prime Boost Pump On	~	•	•	١	٠																	
Eng. 011 Tamperature Eng. 011 Tamp. High C C C C C C C C Eng. 011 Paressure Eng. 011 Quantity Low O1) Filter Bypass C C C C C C C C C Eng. 051 Pressure Eng. 051 Quantity Low O1) Filter Bypass C C C C C C C C C C C C C C C C C C		Fuel Boost Press Low												u	J	J	v	U	J	J	U	ن		
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Low 10 - 1 - 1 - 1 - 1 - 1 - 1 - 1 - 1 - 1		Eng. Oil Temp. High		٥	_	J	u	ى																
		Eng. 011 Pressure	-	٠	-	-	•		_		_	_	•	-	-	-	-	-	-	_		_	_	
		Eng. Oil Pressure Low	U	٠	د	u	Ų	u												u	د	ن	_	
		Eng. 011 Quantity Low							u	J	ں	J			J	U	U	u	u	u				
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		Engine Chip	U	_	J	J	U	ü	u	J	Ü			J	ပ	U	ů	U	ů	Ų	J		-	

I: analog instruments; W: warning light; C: caution light; A: advisory light; T: audio tone; M: master caution light.

TABLE 25. CONTINUED.

				LH-60A	=	-			3/4-R		}		-	\$ _	OH-58C	 -				91-18 			
	PARVETER	TRE/POST	110-3XAT	CRUZSE	HOVER	LAND TROTONN NUCTURE	TRATZ TRATZ	14KE-0FF	CRUISE	HOAEB	TRE/POST	TRATS TRATS	TAKE-OFF	CRUISE	HOVER	ראוס	78E/P05T 1807/1904 1807/1905T	TRE/POST	140-3XAT	CRUISE	HOAEB	0107	TRE/POST SHUTDOMS
urbine	Turbine Inlet Temp.	~	-	_	_																		
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nlet Afr	Inlet Air Press. Neg.																	•	٠	ں			
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NSN 011	MSM 011 Temperature	-		_	_	•	-		_	_								-	•	-	_		
Y5N 041	XDEN Off Temp. High	Ų	u	ü	ü	U U	U	J	J	ن	u	٠	3	=	3	*	•	U	v	U	u	S	S
Chip Mein 1045H	IDEN	u	u	Ü	J	u u	u	v	ပ	Ü	Ü	U U		J	U	u	J	ပ	ပ	U	J	J	J
Chip Int XPSH	XPSH	u	u	ن	ر د	U U												u	ပ	w	J	Ų	Ų
Chip Tail XPSN	MEN	U	Ç	ں	ں	U U						U		Ų	U	ပ	v	U	Ų	v	u	Ü	u
XMSM Of 1 Bypass	Aypass																	u	u	u	د	J	U

TABLE 25. CONTINUED.

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				Ė	UH-60A					CH-47C					OH-58C	×					₹-16	cs.		
SUBSYSTEM	PANNETER	TRE/POST TRATZ	140-3XAT	CRUISE	HOVER	CMAJ	1209/389 NWOGTUH2 1209/389	T804\399 T9AT2	TAXE-OFF	CRUISE	HOVER	TARE/POST	TSO4/3H4 SHUTDOWN THE/POST TRATE	TAICE-OFF	CRUISE	HONER	GMAJ	PME/POST SHUTDOWN THE/POST THATS	TRATE	TAKE-OFF	CKNIZE	HOVER	TVND	TRE/POST SHUTDOMN
Main Rotor	÷	-	-	-	-			_	-	_	_	:	-	-	-	-] .] .] -] -	1 -	1 -	1.	
	Overspeed	-	-	-	•	•	_						ပ	ں	U	٠		U		•				
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XMSA/Engine	1 Torque	-	- .	-	-	-	,	_	_	_	_	-	-	-	-	-	-		-	_	-	٠	-	
Hydraulic	Primary Servo Press Low	U	J	Ų	u	u	u						J	U	J	Ų	J	U	v	U	U	U	U	٠
	Mydraufic Pump Press Low	Ų	U	Ų	U	v	U											ı		,	,	,)	,
	Primary Servo Jam	u	U	U	u	u	Ų																	
	Boost Servo Jam	J	U	Ų	U	U	U																	
	Boost Serve Press Low	J	u	J	v	u	u	U	U	Ü		U U												
	Tail Rotor Servo Press Low	U	v	J	v	ں	u																	
	Backup Pump On	<	~	•	<	•	~																	
	Flt. Ctrl. Myd. Press							-		_	_	_												
	Utility Hyd. Press							-		Ċ	_	-												

TABLE 25. CONTINUED.

			1	W-60A	8	1				CH-47C		}			S - SS C	N N				1	#-18	9	1	1
JOSYSTEM	PANNETER	T2D4\3H4 THAT2	TAKE-OFF	CENTSE	язлон	CAND	T204\3#4 MMOGTUH2 T204\3#4 T#AT2	THATE	140-3XAT	CRUISE	HOVER	LAND TEMPOST SHUTDOMS	T209/3#9 SHUT00MR TMAT2	140-3XVI	CMIZE	HOVER	CMAJ	NHOOTUHS	NHOOTUHS TROA\384 TRATS	140-3XAT	CHITZE	HOAEB	CMAJ	TZO4/384
	Exhaust Temp. High	J	•	•			U	U				u				}		}	[1				
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	Underspeed	Ų	,	•			Ų																	
	Sequence Fail	U	•	•	,		U																	
	Fire	သ	٠	•	,		ں																	
	Generator On	<			,		~																	
	APU On	<	•		,	,	<																	
	Tachometer							_			•	-												
3	Generator(s) Output Low	U	u,	U	J	u	Ü	J	J	U U	ن	v	v	v	Ų	v	Ų	J	Ç	U	U	v	J	Ü
	AC Inverter Output Low												u	u	ں	ں	ں	ں	ں	ت	٠	J	u	·
	Converter(s) Output Low	U	Ų	Ų	U	Ų	Ų																	
	Rectiffer Off						Ī	ی			ں	U												
	Battery Low Charge	u	U	J	U	U	u																	
	Battery Fault	J	U	J	U	U	J																	
	AC Ess. Bus Off	u	Ų	Ų	Ų	u	u																	

TABLE 25. CONTINUED.

				W-60	5				"	G-47C	بر		-	}	Ė	35. E	}		_		# E		(
NSISYSTEM	PARMETER	TRE/POST TARE TARE-OFF	TAKE-OFF	CKNIZE	A3VOH	CMVI	T204\3#4 HUGGTUH2 T204\3#4 T8AT2 T3AT2	18A12	140-3XV1	CHUISE	HOVER	PME/POST	7204/3M9 7204/3M9 78472	TAKE-OFF	CRUISE	HOAEB	CNYT	TZO4/384	TZO4/384 MMOGTURZ TZO4/384 TMATZ	140-3XAT	CRUISE	HOAEB	CMAJ	TZOY\3H4
Sectrical (Cont'd)	Dt. Ess Bus Off	u	u	ب	v	ິ	ن								1		}					1	[
	Ext. Pur. Connected	<	٠	•	•		<	·				-	J						U	٠	•			U
	AC Losdmeter							_	_	-	_	_	_											
	DC Loadmeter							_	_	_	_		_	_	-	-	-	-	-	-	-	_	_	-
	Fire	3	3	=	>	3	>	J	ں	υ	Ų	Ü	U											
It. Path Stab	FIt. Path Stab Sys. Fall	•	Ų	u	v	J																		
tabilator	Stabilator Auto Mode in Up Position	5 -	5 -	53 -	5 -	C/1 C/1 C/1 C/1 C/1 C/1 L/1 L/1 L/1 L/1 L/1 L/1 L/1 L/1 L/1 L	5 -																	
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Hich Bias Actuator	Pitch Blas Fallure	ں	u	ں	ů	٠	Ų																	
best Lock	Not Fully Disengaged	u	u	•		,	ų																	
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TABLE 25. CONTINUED.

			_	GF-60A	ž				5	CH-47C	٠.,		L		OH-59C	u				_	≱ H-16			
SUBSYSTER	PANNETER	TAAT2	TAKE-OFF	CRUISE	HONER	CAND	T204\3M4 NHOGTUH2 T204\3M4 TMAT2	START	730-30AT	CMIZE	HOVER	THATS PRE/POST SHITDOM LARCADOM LARCADOM	7204\384 THAT2	TAKE-OFF	CISTIZE	HONER	CHVI	NMOOTUNE.	TSD4\3M9 MMDQTUH2 TSD4\3M4 TMAT2	440-3391	CRUISE	H3ADH	GWA SHE	T204/3H4
ng. Anti-Ice	Anti-Ice On	•	<	<	<	⋖																		
itot Hest	Pitot Heat On	~	<	<	<	<	<																	
leater	Heater Hot						U	-	ں ن			ن د د												
argo Hook	Cargo Hook Open		<	<	⋖	<	,		ن	Ü	U	٠												
	Hook Armed	•	<	<	<	<																		
arking Brake	Parking Brake On	⋖				,	ن <		Ċ	·														
ng. Starter	Eng. Start Valve Open	ပ																						
anding Gear	Wheel De-Phased						٥	•	·			ن 												
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TABLE 26. SIGNAL SOURCE IMPROVEMENT AREAS.

1. Capacitance Probe (Fuel)

Reliability - 1100 hrs.

Accuracy - .6% analog, .25% digital

Improvements - Plug-in circuit boards, external test points, improved

component reliability

2. Thermistors (Low Fuel)

Reliability - 1100 hrs.

Improvements - Calculation of time remaining rather than quantity

remaining

3. Variable Reluctance Sensor (XMSN 011)

Reliability - 4000 hrs.

Accuracy - 5%

Improvements - Improve accuracy to 1 - 2% with metallized diaphragm with

semi-conductor bridge

4. Temperature Sensor (XMSN 011)

Reliability - Satisfactory

Accuracy - +3°C

Improvements - +1.2°C achievable

5. Thermistor (Engine Oil Temp)

Reliability - 2500 hrs.

Accuracy - +3°C

Improvements - +1.2°C achievable

6. Transducer (Engine Oil Pressure)

Reliability - 4000 hrs.

Accuracy - 5%

Improvements - 1 - 2% achievable via metallized diaphragm with semi-

conductor bridge

TABLE 26. CONTINUED.

7. Thermocouple Harness Probe (TIT)

Reliability - Satisfactory

Accuracy - +5%

Improvements - ±3% possible with multiple element probes; grounding of thermocouple elements is sometimes a problem that may

be solved with closed probes

8. Tach Pulse Sensor (NG, NR)

Reliability - 5000 hrs.

Accuracy - .5% of full scale

Improvements - .1 - .2% achievable; need for improving critical gap problems

9. Shaft Twist Sensor (Torque)

Reliability - Satisfactory

Accuracy - 1% of full scale

Improvements - Use of shaft twist with measurement of phase of pulses

10. IR Sensor (Fire)

Reliability - Satisfactory

Improvements - Improvements in circuitry and false warnings by ambient

IR contamination

11. Chip Detection (Engine, XMSN)

Reliability - 3000 hrs.

Improvements - Ability to distinguish "fuzz" from "chip"; fuzz burnoff;

possible combination of magnetic with electrical grid as filtering system; measurement of debris for maintenance

purposes

12. Mechanical Limit Switch (Oil Filter Pressure Differential)

Reliability - Satisfactory

Improvements - Possible combination of reading with manifold pressure

reading for diagnostic purposes



TABLE 26. CONTINUED.

13. DC Power Monitor

Improvements - Develop an improved method of monitoring status of DC bus. Present method provides only go/no-go information, and there is need for a more sophisticated system capable of warning of degraded operation.

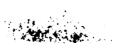
14. Fuel Flow Measurement

Reliability - Mass flow type sensor is fair. Volumetric type is excellent. Accuracy - 1 - 2% of 800 lb/hr

Improvements - Mass flow contamination is a problem; volumetric type requires temperature compensation, and use of microprocessor is recommended.

15. Aircraft Weight Measurement

Improvements - Investigate locating weight sensors on landing gear and other locations to facilitate aircraft weight and CG measurement.



LEGEND: TABLES 27-30.

Column	Code	Explanation
Dimensions	#	Quantitative dimension only dis- played
} ·	Q	Qualitative dimension only dis- played
	В	Both qualitative and quantita- tive dimensions displayed
System	Fuel	Related fuel system parameters also displayed
	Engine	Related engine system parameters also displayed
	XMSN	Related XMSN system parameters also displayed
	Hydraulic	Related hydraulic system para- meters also displayed
	Electrical	Related electrical system para- meters also displayed
	АРИ	Related APU system parameters also displayed
Auto Response	D	Auto response is desirable and should be considered
	N	No desirability of auto response beyond that currently available
Auto Feedback	D	Feedback indicating auto re- sponse performed is desirable
	N	Feedback not desirable
Auto Recording	D	Auto recording of parameter variables is desirable
	N	Auto recording of parameter variables is not desirable
		}

LEGEND. CONTINUED.

Column	Code	Explanation
Urgency	1	Safety Critical
	2	Mission Essential
	3	Maintenance required/advisory
	-	Optionally accessed, no urgency assigned
Priority	1,2,,N	Ranked priority of message
	*	Optionally accessed, no priority assigned
Display Logic	W	Warning Message, Displayed by Exception
	С	Caution Message, Displayed by Exception
	Р	Precaution Message, Displayed By Exception
	М	Manually accessed information

TABLE 27. UH-60A DISPLAY LOGIC.

Parameter/Message	Urgency	Priority	Display Logic	Dimension	System	Auto Response	Auto Feedback	Au .o Recording
LOW ROLD RPM	M		*	80	Engine	z		۵
Low Rotor RPM		,	U	•	Engine	z		•
(Rotor RPM)	•	*	Σ	80	Engine	Z		
#) Engine Out	1	~	3	o	Engine	z		٥
#2 Engine Out		m	3	0	Engine	z		۵
#1 Engine Fire	-	4	3	0	Engine	z		۵
12 Engine Fire	ŗ	\$	3	<i>o</i>	Engine	z		۵
APU Fire	-	•	3	8	APı	z		۵
Stabilator Inoperative	-	80	ن	o	;	22		۵
#1 Overtorque	7	61	ه ن	∞ ∞	Ungine Engine	zz		00
#2 Overtorque #2 Overtorque		10	ں م	80 80	Engine Engine	ZZ		۵۵
(#1 Torque)		*	x	&	Engine	Z		z
(#2 Torque)	• •	*	£	6 0	Engine	æ		z
Main Rotor Overspeed Main Rotor Overspeed		11 63	υ Δ .	æ æ	Engine Engine	2 2		۵ ۵

	TABLE	E 27. CON	27. CONTINUED.				TABLE 1 Page 2	72
Parameter/Message	Urgency	Priority	Display Logic	Dimension	System	Auto Response	Auto	Auto
IFF Inoperative	.	12	ن	0	!	<i>z</i>		۵
#1 Np High/Low	-	13	U	85	Engine	z	· · · · ·	٥
#1 Np High/Low	-	25	۵.	8	Engine	z		۵
(#1 Np)	•	*	¥	80	Engine		-	
#2 Np High/Low	-	14	J	æ	Engine	z		۵
#2 Np High/Low	-	99	۵.	80	Engine	z		
(#2 Np)	•	•	E	89	Engine			
#1 Fue Pressure Low		15	U	*	Fuel	٥		۵
(#1 Fuel Pressure)			£	*	Fue	z		z
42 Fiss Pressure Cut		16		*	Fue	۵		۵
(#2 Fuel Pressure)	•	*	Σ	*	Fue	· Z		z
10 T		17	ں 		Engine	z 		۵
41 NG H19h		· 3 8	· a		Engine	z		٥
(#1 NG)	•	*	E	8	Engine			æ
12 NG High	~	18	U	8	Engine	z		٥
#2 Ng High	-	29	۵.	60	Engine	z		۵
(#2 Ng)	,	*	¥	•	Engine	z		z
MSN 011 Pressure Low/High		61	ں 	s	XMSN	=		۵
XXXN Oil Pressure Low/High	-	89	۵	89	XMSN	×		۵
(XMSN 011 Pressure)	•	*	Σ	8	XMSN	z		z
XMSN 041 Temperature High		 		~	MACH	2		-
WSW Dil Temperature High		3 8	, 0.	, @	NSW	: #		. 0
(XFSN 01) Temperature)	• •	*	. E	. es	XMSN	· z		×

TABLE 27. CONTINUED.

21 C Q Q XMSN 22 C Q Q XMSN 23 C Q Q Engine 24 C Q Q Engine 25 C Q Q Engine 27 C B B Engine 27 C B B Engine 28 C B B Engine 28 C B B Engine 29 C B B Engine 29 C B B Engine 30 C B B Engine 30 C B B Engine 31 P B B Engine 32 C B B Engine 33 P B B Engine 34 B B Engine 35 C B B Engine 36 C B B Engine 37 P B B Engine 38 C B B Engine 38 Engine 39 C B B Engine 30 C B B Engine 30 C B B Engine 31 B B Engine 32 C B B Engine 34 B B Engine	Parameter/Message	Urgency	Priority	Display Logic	Dimens ton	System	Auto Response	Auto Feedback	Auto Recording
Low/Migh Low/Mi	Chip Main XMSN	1		Ų	o		ż		<u> </u>
1 23 C Q	Chip Intermediate XMSN	1	22	ن	o	XMSN	Z		٥
Low/High Low/Hi	Chip Tail XMSN	1	æ	ပ	0	XPSN	Z	200	•
Low/High Low/High Low/High Low/High Tre Hi	#1 Engine Chip	1	54	U	0	Engine	z		٥
Low/High	#2 Engine Chip	1	52	ن 	0	Engine	z		۵
Low/High	#1 Engine Oil Pressure Low/High	1	56	J	85	Engine	z		۵
Low/High Low/High Low/High Tre Hi	#1 Engine Oil Pressure Low/High	-	70	: ۵	60	Engine	2:		۵;
1 Pressure Low/High 1 27 C B 1 Pressure Low/High 1 71 P B B 1 Temperature High 1 72 P B B 1 Temperature High 1 72 P B B 1 Temperature High 1 73 P B B 1 Temperature High 1 73 P B B 1 Temperature High 1 73 P B B 1 Temperature High 1 73 P B B 1 Temperature High 1 73 P B B 1 Temperature High 1 73 P P B B 1 Temperature)	(#1 Engine Oil Pressure)	•	•	x	∞	Engine	z		*
11 Pressure Low/High	#2 Engine Oil Pressure Low/High	1	22	U	8	Engine	2		٥
11 Pressure) 1 Temperature High	#2 Engine 011 Pressure Low/High	-	11	۵.	80	Engine	z		٥
Temperature High	(#2 Engine Oil Pressure)	•	•	I	ec	Engine	z		Z
1 Temperature High 1 72 P B B 1 Temperature)	#1 Engine Oil Temperature High	٦	28	<u>ں</u>	.	Engine	z		6
1) Temperature High 1 29 C B 1) Temperature High 1 73 P B 1) Temperature High -	#1 Engine Oil Temperature High	1	72	_	6	Engine	z		٥
1 Temperature High 1 29 C B 1 Temperature High 1 73 P B 1 Temperature) - * M B 1 1 30 C B 1 1 74 P B B 1 1 74 P B B 1 1 74 P B B 1 1 74 P B B 1 1 74 P B B 1 1 74 P B B 1 1 74 P B B 1 1 74 P B B 1 1 74 P P B B 1 1 74 P P B B 1 1 74 P P B B 1 1 74 P P P P B B 1 1 74 P P P P P P P P P P P P P P P P P P	(#1 Engine Oil Temperature)	•	•	=	60	Engine	Z		=
1) Temperature High	#2 Engine Oil Temperature High	-	62	ں 	85	Engine	z		٥
1) Temperature) - • M B B 1 30 C B 1 74 P B B B B B B B B B B B B B B B B B B	#2 Engine Oil Temperature High	1	73	۰	6 0	Engine	z		_
1 30 C	(#2 Engine Oil Temperature)	•	•	E	6 0	Engine	æ		z
74 74 70 80 80	#1 TGT H1gh	7	30	U 	80	Engine	2		۵
· · · · · · · · · · · · · · · · ·	#1 TGT High	-	74	۵.	•	Engine	æ		٥
	(+1 161)	1	•	=	80	Engine	æ		z

TABLE 27. CONTINUED.

Parameter/Message	Urgency	Priority	Display Logic	Ofmens ton	System	Auto Response	Auto Feedback	Auto Recording
#2 TGT High	1	31	U	80	Engine	z	:	
#2 TGT HIGH	-	75	۵.	89	Engine	æ		0
((#2 161)	•	*	Σ	∞	Engine	z		=
#1 Primary Servo Pressure Low		32	<i>.</i>	0	ı	Z		٥
(#1 Primary Servo Pressure)	•	•	×	*	Hydraul ic	z		z
#2 Primary Servo Pressure Low		33	U	0	•	æ		•
(#2 Primary Servo Pressure)	•	•	£	•	Hydraulic	z		2
#1 Primary Servo Jam	-	35	υ 	0	•	z		6
#2 Primary Servo Jam		38	ں 	8	,	z		۵
Tail Rotor Servo Jam		98	U	·	•	z		
#1 Mydraulic Pump Pressure Low	-	37	υ 	0	•	z		٥
(#1 Mydraulic Pump Pressure)	•	*	X	*	Hydraulic	z		z
#2 Mydraulic Pump Pressure Low		ب ج	ر ي	o •		z :		_ a
	•	•	Ε	•	Ji inguali	E		E
#1 Fuel Low	1	39	ں —	*	Fuel	z		_
#1 Fuel Low	-	76	۵.	*	Fuel	*		٥
(#1 Fuel (Time to go)	•	•	E	*	Fuel	Z		z
(#1 Fuel (1bs remaining)	•	•	Σ	•	Fuel	æ		z
_								

TABLE 27. CONTINUED.

Parameter/Message	Urgency	Priority	Display Logic	Dimension	System	Auto	Auto Feedback	Record
12 fuel Low	1	04	ပ	*	Fuel			
#2 Fuel Low		"	۵	*	Fuel	z		_
(#2 Fuel (Time to go)	•		Σ	*	Fuel	z		~
(#2 Fuel (Lbs Remaining)		•	×	•	Fue	×		z
(Total Fuel (time to go)		*	*	*	Fue]	z	-	
(Total Fuel (Lbs Remaining)	· 	•	x	*	Fuel	z		. *
SAS OFF	-	14	Ų	<i>-</i>	;	z		
Fit Path Stab Sys Inop	-	45	ن 	0	;	z 		0
DC Ess Bus Off (DC Ess Bus Load)	8 1	+ 43	ပန္	o	Electrical	z z		a z
AC Ess Bus Off (AC Ess Bus Load)	۷ ،	4 .	U E	~ ~	Electrical	z z		^ ×
Pitch Bias Failure		45	.	0	:	≥		9
#1 Generator Output Low (#1 Generator Output)	~ 1	9 +	υx	o .	 Electrical	z z		0 z
#2 Generator Output Low (#2 Generator Output)	N 1	74 +	υx	o *	Electrical	2 2		<u> </u>
#1 Converter Output Low (#1 Converter Output)	~ .	85 +	υX	o*	Electrical	* *		0 z

TABLE 27. CONTINUED.

	Urgency	Priority	Logic	Dimension	System	Response	Feedback	Recording
#2 Converter Output Low	2	49	U	0	•	z		•
(#2 Converter Output)	•	*	x	*	Electrical	z		z
Boost Servo Jam	2	S	<u>ں</u>	0		z		٥
#1 Oil Filter Bypass	2	- 51	ں	<i>-</i>		z		٥
#2 Oil Filter Bypass	2	25	U	~	•	z		<u> </u>
XMSN Oil Bypass	5	53.	ں	-	1	z		6
#1 Fuel Filter Bypass #2 Fuel Filter Bypass	2 2	54	ပပ	<u>-</u>	٠,	zz		00
Battery Fault	m	99	υ ———	۰	•	z		٥
Battery Low Charge	м	25	ں	•	•	z		<u> </u>
APU Fail		8 8	ن 	0	APU	z		<u> </u>
Gust Lock Not Disengaged		26	U	0	•	z		a
External Power Connected	E	8	ں —	<i>o</i>	•	z		۵
Backup Pump On	ĸ	82	«	~	•	z		z
Cargo Hook Armed	м м	80	≪ ≪	<i>-</i>		z z		* z
Prime Boost Pump On APU On	т м	81	≪ ≪	00	, ,	z z		z z

TABLE 27. CONTINUED.

TABLE 28. CH-47C DISPLAY LOGIC.

Parameter/Message	Urgency	Priority	Display Logic	Dimension	System	Auto	Auto Feedback	Auto Recording
Low Rotor RPM		-	38	66	Engine	z		٥
Low Rotor RPM	-	7	U	80	Engine	z		٥
(Rotor RPM)	,	•	E	89	Engine	z		*
#1 Engine Out		2	3	0	Engine	2		
#2 Engine Out	-	ю	3	0	Engine	z		
#1 Engine Fire		4	3	0	Engine	z		۵.
42 Engine Fire	-	s	3	0	Engine	z		
APU Fire	-	ڼ	3	0	APU	z 		<u> </u>
#1 Overtorque		80	ű	60	Engine	z		۵
#1 Overtorque		4	۵.	65	Engine	z		_
#2 Overtorque	1	6	ن	•	Engine	*		۵
#2 Overtorque	-	99	۵.	ھ	Engine	z 		٥
(#1 Torque)	•	*	E	6	Engine	z		*
(#2 Torque)	•	*	3 C	•	Engine	*		*
Rotor Overspeed Rotor Overspeed		00 99	ں م	60 85	Engine Engine	z z		
IFF Inoperative	•				:	-		_

TABLE 28. CONTINUED.

	3001	100 to 07 angul	OCT THOSE					
Parameter/Wessage	Urgency	Priority	Display Logic	Dimension	System	Auto Response	Auto Feedback	Auto Recording
#1 Main Fuel Pressure Low	-	12	U	*	Fuel	۵	٥	٥
(#1 Main Fuel Pressure)	•	•	Σ	**	Fuel	z		z
	•			•		•		
#2 Main Fuel Pressure Low	-	£1	ن	•	rue	-	>	<u> </u>
(#2 Main Fuel Pressure)	,	*	I	*	Fue	z		z
#1 Fud Aux Pressure Ou	-	14	U	*	Fue	٥	6	٥
(#1 Fwd Aux Pressure)	, ,	*	•	•	Fue	Z		z
#2 Fed Aux Pressure Low		15	v	*	Fuel	۵	٥	٥
(#2 Fwd Aux Pressure)	•	*	E	*	Fue	z		z
	,	;	•	,	•	•	,	
#1 Aft Aux Pressure Low	~=	16	ິງ	*	Fuel	۵	<u> </u>	<u> </u>
(#1 Aft Aux Pressure)	•	*	E	•	Fue	z		z
	•	!	•	,	•	•	•	•
#2 Aft Aux Pressure Low	-	`	ں	•	- Fue	a	a	-
#2 Aft Aux Pressure)	•	*	×	•	Fuel	Z		z
						;		
#1 Cross Feed Fuel Valve		18	u —	•	:	z		<u> </u>
#2 Cross Feed Fuel Valve	-	19	U	•	:	z		٥
#1 Engine Fuel Valve	-	23	U	•	:	z		٥
#2 Engine Fuel Valve	7	21	u	3 p.	:	Z		٥
#1 Ng. High	1	22	U		Engine	2		6
#1 Ng High	-	29	۰	80	Engine	2		_
(\$1 Mg)	ŀ	*	X	80	Engine	z		=
	-							
	-							

TABLE 28. CONTINUED.

Parameter/Message	Urgency	Priority	Display Logic	Dimension	System	Auto Response	Auto Feedback	Auto Recording
#2 NG High		23	U	60	Engine	æ		
#2 NG High	-	89	۵	60	Engine	×		۵
(#2 NG)	,	*	£	80	Engine	7.		z
Fwd XMSN 011 Pressure Low/High	_	24	v	80	XMSN	z		۵
Fwd XMSN 011 Pressure Low/High	1	69	۵	80	XMSN	×		٥
(Fwd XMSN 011 Pressure)	•	*	Σ	80	NSHX	×		z
Aft XMSM Oil Pressure Low/High	-	52	υ	80	XPSN	z		٥
Aft XMSN Oil Pressure Low/High	1	70	•	89	XMSN	z		6
(Aft XMSN Oil Pressure)	•	*	×	8	KINSK	æ		*
Mix XMSM Oil Pressure Low/High		56	U	89	XMSN	z		٥
Mix XMSN 0il Pressure Low/High	-	7.1	۵.	60	XMSN	z		۵
(Mix XMSN Oil Pressure)	•	*	x	80	NSMX	z		*
Left XDSN 011 Pressure Low/High		22	ن	80	XPSN	z		۵
Left XMSM Oil Pressure Low/High	1	72	۵.	8	XMSN	z		٥
(Left XMSM Oil Pressure)	•	*	£	•	NSWX	z		z
Right XMSN Oil Pressure Low/High		28	ن 	83	XMSN	Z		0
Right XMSN 011 Pressure Low/High	-	73	۵.	8	XPISN	z		٥
(Right XMSM Oil Pressure)		*	E	60	XMSN	*		æ
Fwd XXSN Oil Temperature High	-	53	ပ	80	KMSM	2		٥
Fwd XMSM Oil Temperature High	-	74	•	8	XMSN	×		0
(Fwd XDGN Oil Temperature)		*	I	8	XMSIN	×		z
						_		

TABLE 28. CONTINUED.

Parameter/Nessage	Urgency	Priority	Display Logic	Dimension	System	Auto Response	Auto Feedback	Auto Recording
Aft XMSN Oil Temperature High	-	%	U	80	NSMX	z		٥
Aft XMSM Oil Temperature High	-	75	۵.	8	NSWX	z		۵
(Aft XMSN Oil Temperature)		*	Σ	6	XMSN	z		z
Mix XMSN Oil Temperature High	-	ж —	U	6	XMSN	z		٥
Mix XMSM Oil Temperature High	-	92	م	80	NSMX	Z		۵
(Mix XMSM Oil Temperature)		*	Σ	80	XMSN	Z		z
Left XMSM Oil Temperature High	-	35	U	80	XMSN	z		
Left XMSN Oil Temperature High		"	۵.	8	NSMX	z		_
(Left XMSM Oil Temperature)	ŀ	*	Σ	ω	XMSN	z		z
Right XMSN Oil Temperature High	7	æ	ن	89	XMSN	z		<u> </u>
Right XMSN Oil Temperature High	-	78	۵	80	NSMX	Z		٥
(Right XMSN Oil Temperature)		*	E	60	XMSN	z		z
XVSN Chip	-	¥.	ن	٥	XMSN	z		۵
)) Engine Chip	-	5 2	ن 	o	Engine	z		۵
82 Engine Chip		36	U	0	Engine	z		٥
#] Engine Oil Pressure Low/High		37	Ų	89	Engine	z		٥
#1 Eingine Oil Pressure Low/High	-	79	۵	89	Engine	z		٥
(#1 Engine Oil Pressure)	•	*	T	∞	Engine	z		Z
#2 Engine 011 Pressure Low/High	1	38	U	ω.	Engine	z		٥
#2 Engine Oil Pressure Low/High	-	88	۵	æ	Engine	z		_
(#2 Engine Oil Pressure)	•	*	I	60	Engine	z		z

TABLE 28. CONTINUED.

## Engine Oil Temperature High ## Engine ## ## Engine ## ## Engine ## ## Engine ## ## Engine ## ## Engine ## ## Engine ## ## Engine ## ## Engine ## ## ## Engine ## ## ## ## Engine ## ## ## ## ## ## ## ## ## ## ## ## ##	Parameter/Message	Urgency	Priority	Display Logic	Dimension	System	Auto Response	Auto Feedback	Auto Recording
Temperature High	#1 Engine Oil Temperature High	-	39	ပ	80	Engine	z		:
Temperature High	#1 Engine Oil Temperature High	7	81	۵	8	Engine	z		0
Temperature High	(#1 Engine Oil Temperature)	•	*	×	8	Engine	æ		æ
Temperature High	#2 Engine Oil Temperature High		\$	u	œ	Enoine	z		_
	#2 Engine Oil Temperature High		88	۔	80	Engine	: =		
Quantity Low	(#2 Engine Oil Temperature)	•	*	E	80	Engine	Z		z
Quantity Low	#1 Engine Oil Quantity Low	-	4	Ú	O	Engine	z		۵
Pump Pressure Low 1 43 C B Engine N Pump Pressure Low 1 44 C B Engine N C Pump Pressure Low 1 45 C Q N C Pump Pressure Low 1 46 C Q N C Pump Pressure Low 1 46 C Q N C Pump Pressure Low 1 46 C Q N C Pump Pressure Low 1 46 C Q N Low 1 46 C Q N Low 1 47 C # Fuel N Low 1 85 P # Fuel D D	#2 Engine Oil Quantity Low	1	42	v	0	Engine	z		۵
Pump Pressure Low 1 83 P B Engine N Pump Pressure Low 1 44 C B Engine N Fump Pressure Low 1 45 C Q N Fump Pressure Low 1 46 C Q N Fump Pressure Low 1 46 C Q N Fump Pressure Low 1 46 C Q N Fump Pressure Low 1 46 C Q N Low 1 46 C Q N Low 1 47 C P Fuel N	DEST HIGH		43	Ü	8	Engine	z	· -	<u> </u>
Pump Pressure Low 1 44 C B Engine N Pump Pressure Low 1 44 C B Engine N c Pump Pressure Low 1 45 C Q N c Pump Pressure Low 1 46 C Q N c Pump Pressure Low 1 46 C Q N c Pump Pressure Low 1 46 C Q N c Pump Pressure Low 1 46 C Q N c Pump Pressure Low 1 46 C Q N c Pump Pressure Low 1 46 C Q N c Pump Pressure Low 1 46 C Q N c Pump Pressure Low 1 46 C Q N c Pump Pressure Low 1 46 C Q	#1 EGT High	-	88	۵.	80	Engine	×		٥
1 44 C B Engine N B Engine N B Engine N B Engine N B Engine N B Engine N B Engine N B Engine N B Engine N B Engine N B Engine N B B Engine N B B Engine N B B B B B B B B B B B B B B B B B B	(#1 EGT)	•	*	x	æ	Engine	z		×
1 84 P B Engine N 1 45 C Q N 1 46 C Q Q N 1 46 C Q Q N 1 47 C Q P P 1 85 P P Fuel N	P2 EGT HIGH		44	v	80	Engine	z		۵
1 45 C Q N * M # Hydraulic N * M # Hydraulic N * M # Hydraulic N * M # Fuel D D	#2 EGT High	-	*	۵	60	Engine	z		٥
1 45 C Q N Hydraulic N	(#2 EGT)	,	*	Σ	80	Engine	z		z
1 46 C Q N Hydraulic N Hydr	#1 Hydraulic Pump Pressure Low	-	45	U	0	;	Z		
1 46 C Q N Hydraulic N Hydraulic N 1 47 C Fuel D D 1 1 85 P Fuel N	(#1 Hydraulic Pump Pressure)	•	*	X	*	Hydraulic	Z		z
1 47 C # Fuel D D 1 1 885 P # Fuel N	#2 Hydraulic Pump Pressure Low		46	υ 	~	:	z		٥
1 47 C # Fuel D D I	(#2 Hydraulic Pump Pressure)	,	*	Ξ	•	Hydraulic	2		z
1 85 P # Fue! N	#1 Main Fuel Low		47	ပ	*	Fuel	a		0
	#1 Main Fuel Low	1	85	۵	•	Fue	z		۵

TABLE 28. CONTINUED.

Parameter/Nessage	Urgency	Priority	Display Logic	Dimension	System	Auto Response	Auto Feedback	Auto
(#1 Main Fue] (Time to go)		*	×	*	Fuel	z		z
(#1 Main Fuel (Lbs remaining)	•	*	x	*	Fuel	z		z
· · · · · · · · · · · · · · · · · · ·	-	86		**	Fue	6	٥	6
The low control of the control of th	• -	2 %	۵ ۵	. 4	Fuel	. 2		
(as the first (Time to so)	• (3 *	. x	•	Fuel	: =		· z
(#2 Main Fuel (Lbs remaining)		*	: E	* **:	Fuel	z		z
		•		*	[3]	£	_	·-
#1 Fwd Aux Fuel Low	-	4	د	•	1	3	•	s :
#1 Fwd Aux Fuel Low		87	۵	*	Fuel	z		z
(#1 Fwd Aux Fuel (Time to go)		*	Σ	**	Fuel	z		
(#1 Fwd Aux Fuel (Lbs remaining)	•	*	Σ	*	Fuel	z		
#2 Fwd Aux Fuel Low	1	90	၁	•	Fuel	۵	٥	۵
#2 Fwd Aux Fuel Low		88	۵	*	Fuel	z		Z
(#2 Fwd Aux Fuel (time to go)		•	×	*	Fuel	z		
(#2 Fwd Aux Fuel (1bs remaining)	1	*	I	*	Fuel	z		
							(
#1 Aft Aux Fuel Low	1	51	ں 	*	Fuel	۵	۵	<u> </u>
#1 Aft Aux Fuel Low	1	68	۵.	*	Fuel	Z	<u>.</u>	z
(#1 Aft Aux Fuel (Time to go)	ı	*	£	*	Fuel	z		
(#1 Aft Aux Fuel (Lbs remaining)	•	*	Σ	*	Fuel	z		
#2 Aft Aux Fuel Low	-	25	ပ	*	Fue	۵	٥	۵
#2 Aft Aux Fuel Low	1	8	۵	*	Fuel	z		z
(#2 Aft Aux Fuel (Time to go)	•	*	Œ	*	Fuel	z	_	
(#2 Aft Aux Fuel (Lbs remaining)	.•	•	E	*	Fue 3	z		
_	_		_	_		_	_	_

TABLE 28. CONTINUED.

Parameter/Message	Urgency	Priority	Display Logic	Dimension	System	Auto Response	Auto Feedback	Auto Recording
(Total Fuel (Time to go)		*	Œ	*	Fuel	2		2
(Total Fuel (Lbs remaining)	•	*	Σ	78:	Fuel	z		z
SAS Off	-	53	Ü	ō	;	z		٥
#1 Generator Output Low	2	54	ں	;	:	z		۵
(#1 Generator Output)	•	*	Σ	*	Electrical	z		z
#2 Generator Output Low	-	- 55	υ —	0	;	z		٥
(#2 Generator Output)		*	Σ	*	Electrical	z		z
#1 Rectifier Output Low	2	95	υ 	0	:	z		۵
(#1 Rectifier Output)	•	*	£	*	Electrical	z		z
#2 Rectifier Output Low	2	23	υ 	0	;	z		۵
(#2 Rectifier Output)	•	*	Σ	*	Electrical	z		z
Boost Servo Pressure Loм	2	88	U	٥	:	æ		۵
Apy Fatl	8	8	ن —	0	APU	z		
Utility Hydraulic Pressure Low	2	65	v	ò	:	Z		٥
External Power Connected	м	19	U	0	:	z		*
Whee? De-Phased	т	62	v	0	:	z		۵
Heater Hot	ĸ	63	U	ð	;	z		<i>a</i>

Parameter/Message	Urgency	Priority	Display Logic	Dimension	System	Auto Response	Auto Feedback	Recording
#1 N ₁ Control Loop Energized	,	91	₹ 4	ò	:	z		
#2 N ₁ Control Loop Energized	•	85	⋖	O	:	z		۵
Cargo Hook Open	ı	83	⋖	0	:	z		z
Parking Brake On	1		₹	0	;	z		z
Fuel Precaution Set At	e 	56	⋖	**	:	z		z
								·····
	_							

TABLE 29. AH-1G DISPLAY LOGIC.

Parameter/Message	Urgency	Priority	Display Logic	Dimension	System	Auto Response	Auto Feedback	Auto Recording
Low Rotor RPM	1	1	3	80		=		. 0
LOW Rotor RPM		4	J	80	Engine	z		_
(Rotor RPM)	•	*	I	6	Engine	z		2
Engine Out		8	3	c,	Engine	Z		
Engine Fire		<i>w</i>	3	0	Engine	z		٥
Overtorque		<u>ب</u>	U	60	Engine	z		۵
Overtorque		31	_	89	Engine	z		•
(Torque)	•	•	Œ	89	Engine	· •		2
Rotor Overspeed		•	U	89	Engine	z	-	۵
Rotor Overspeed		32	۵.	60	Engine	z		٥
IFF Inoperative	-	,	.	o	:	*		٥
Np High/Low		80	v	&	Engine	2		۵
Np High/Low		33	۵	•	Engine	2		٥
(du)	•	*	x	\$	Engine	z		×
Fuel Pressure Low		6	U	•	Fuel	۵	۵	۵
(Fuel Pressure)		•	r	•	Fuel	z		z
Mg High		01	.	•	Engine	z		٥
Ng High	-	*	۵.	•	Engine	z		٥
(mg)	•	•	x	•	Engine	z		=

TABLE 29. CONTINUED.

WGN Oil Pressure Low/High	Urgency	Priority	Display Legic	Dimens ion	System	Response	Auto	Recording
	-	=======================================	J	8	KMSN	z		٥
MICH OF Descende Joh/High		32	۵.	80	NSWY	z		_
(xMSN Oil Pressure)	•	*	E	ω	XMSN	z		z
de la constant de la		-12	<u>.</u>	80	XMSN	*		۵
Mon of Temperature migh		36 1		80	XMSN	z		<u> </u>
(XMSN Oil Temperature)	. ,	*	Ε	89	XMSN	*		*
Chip Main XMSN		13	ပ 	0	XPSN	z		6
Chip Intermediate XMSN		7.	U	b	XMSN	z 		0
Chip Tail XDSN		51	ن	0	XMSN	E		<u> </u>
Engine Chip		91	v	o	Engine	z 		۵
Engine Oil Pressure Low/High		17	ں 	∞	Engine	z		•
Engine 011 Pressure Low/High (Engine 011 Pressure)		37	a \$	∞ ∞	Engine	* *		0 Z
	-			a		=		0
Engine Oil Temperature High		9 89 ——	. a	s 60	Engine	: E		
(Engine Oil Temperature)	•	*	Σ	∞	Engine	z 		z
EGT High		19	ں —	6	Engine	z		<u> </u>
EGT High	-	39	۵.	9	Engine	z		۵
(EGT)	•	*	Ξ.	6	Engine	z		z

TABLE 29. CONTINUED.

	Urgency	Priority	10g1	Dimension	System	Response	Feedback	Recording
5		02	ပ	0	:	Z		_
(#1 Hydraulic Pressure)	1	•	¥	•	Hydraulic	z		z
#2 Hydraulic Pressure Low	-	21	U	0	1	z		۵
(#2 hydraulic Pressure)		٠	x	•	Hydraulic	z		2
Fuel Low		- 22	<u>ں</u>	*	Fuel	z		۵
Fuel Low	-	9	۵.	*	Fuel	z		۵
(Fuel (Time to go)	•	*	=	*	Fuel	Z		z
(Fuel (Lbs remaining)		•	E	*	Fuel	z		z
DC Generator Output Low	2	23	υ —	0	:	z		٥
(DC Generator Output)	1	•	¥	•	Electrical	z		z
AC Inverter Output Low	~	24	S	~	:	z		<u> </u>
(AC Inverter Output)		*	I	*	Electrical	z		z
Oil Filter Bypass		52	ن	0	;	Z	·	٥
XPGM 011 Bypass	- 5	56	U	0	;	z		٥
Fuel Filter Bypass	~~~	23	U	0	:	z		a
Fud Fuel Boost Pressure Low	c4	78	υ —	0	:	z		•
Aft Fuel Boost Pressure Low	~	58	v	0	;	z		٥
External Power Connected	е	8	U	~	:	z		z

TABLE 30. OH-58C DISPLAY LOGIC.

		1000		•				
Parameter/Message	Ungency	Priority	Display Logic	Dimension	System	Auto Response	Auto Feedback	Auto Recording
Low Rotor RPM	1	1	3	80	Engine	æ		
Low Rotor RPM	1	4	ပ	80	Engine	z		۵
(Rotor RPM)	•	*	E	40	Engine	z		æ
Engine Out	H	2	3	<i>~</i>	Engine	z		۵
Engine Fire	-	۳	38	~	Engine	*		۵
Overtorque	-	S.	ပ	8	Engine	z		٥
Overtorque		22	a.	60	Engine	z	_	a
(Torque)	•	*	2	66	Engine	Z		z
Rotor Overspeed	-	9	U	•	Engine	z		۵
Rotor Overspeed	-	58	۵	∞	Engine	z		9
IFF Inoperative	-	2	ú	<i>-</i>	:	z		۵
Np Low	7	œ	ပ	80	Engine	*		9
th Low	7	53	•	8	Engine	z		٥
(dy)	,	*	Σ	8	Engine	z		z
Fuel Pressure Low	-	6	ပ	•	Fuel	٥	٥	٥
(Fuel Pressure)	,	*	Σ	•	Fuel	*		=
Ng 1195		10	ပ	6	Engine	z		•
Ng High	-	30	۵.	20	Engine	=		٥
(M ₂)	•	*	æ	æ	Engine	2		=

TABLE 30. CONTINUED.

Parameter/Message	Urgency	Priority	Display Logic	Dimension	System	Auto Response	Auto Feedback	Auto
WEN Oil Pressure Low/High	1	n	٥		NSHX			•
XMSN Oil Pressure Low/High		31	۵.	80	NSWX	z		٥
(XMSN 011 Pressure)	1	۲	E	6	XMSN	z		z
XMSN 013 Temperature High	1	12	ں	~	NSMX	.		
AMSN Oil Temperature High	-	8	۔	. eo	NSMX	: z		•
(XMSN Oil Temperature)	,	•	x	60	XMSN	z		*
Chip Main XMSN	r-I	13	U	٥	NSWX	z		٥
Chip Intermediate XMSN	+ 4	14	υ 	0	NSMX	z		•
Chip Tail XMSN	-	15	U	0	NSHX	z		۵
Engine Chip	1	16	ن -	0	Engine	z		٥
Engine Oil Pressure Low/High	-	17	υ ——	∞	Engine	Z		٥
Engine Oil Pressure Low/High	-	33	۵	8	Engine	z		٥
(Engine Oil Pressure)	•	*	*	80	Engine	z		*
Engine Oil Temperature Low/High		18	ن	€	Engine	=		_
Engine Oil Temperature Low/High		34	۵	80	Engine	z		٥
(Engine Oil Temperature)	•	*	*	8	Engine	z		Z
TOT High	1	19	ں —	•	Engine	2		٥
10Т нізh	7	35	۵	80	Engine	2		۵
(101)		*	E	œ	Fnatne	=		=

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							į	1
Parameter/Message	Urgency	Priority	Display Logic	Dimension	System	Auto Response	Auto Feedback	Auto Recordin
Mydraulic pressure low	-	82	ں	0	:	z		•
(Hydraulic pressure)	•	•	x	•	Hydraulic	z		z
File 1 Low	,	21	ں 	ų	Fue.	2		_
Fuel Low	•••	*	۵.	•	Fuel	=		٥
(Fuel (Time to go)	,	•	×	•	Fuel	×		z
(fuel (Lbs remaining)	,	*	I	•	Fee	z		*
DC Generator Output Low	2	23	υ ———	٥	:	z		_
DC Generator Output			*	•	Electrical	z		*
AC Generator Output Low	2	23	v	o	;	z		_
AC Generator Output			*	*	Electrical	*		*
011 Filter Bypass	8	24	ບໍ	6	:	z		٥
Fuel Filter Bypass	2	52		o	:	z		0
Fuel Boost Pressure Low	8	56	u	0	:	Z	 	
Fuel Precaution Set At	ю	37	≪	•	;	z		z
							-	
								•==

TABLE 31. UH-60A RELATED SYSTEM PARAMETERS.

System	Parameters
Fuel	Time Remaining (#1, #2, Total) Lbs Remaining (#1, #2, Total) Pressure (#1, #2)
Engine	Torque (#1, #2) NR NP (#1, #2) NG (#1, #2) TGT (#1, #2) Oil Temp (#1, #2) Oil PSI (#1, #2)
XMSN	Pressure Temperature

TABLE 31. CONTINUED.

Fuel	Parameters
Hydraulics	Flt Ctrl Pressure (#1, #2) Primary Servo Pressure (#1, #2) T/R Servo Pressure (#1, #2)
Electrical	DC Gen Output (#1, #2) AC Conv Output (#1, #2) AC Ess Bus Status DC Ess Bus Status Pri Bus Status (#1, #2) Monitor Bus Status (#1, #2)
APU	NP EGT Oil PSI Accumulator PSI Generator Output

TABLE 32. CH-47C RELATED SYSTEM PARAMETERS.

System	Parameters
Fuel	Time Remaining (Main, Fwd Aux, Aft Aux: #1, #2, Total)
	Lbs Remaining (Main, Fwd Aux, Aft Aux: #1, #2, Total)
	Pressure (Main, Fwd Aux, Aft Aux: #1, #2)
Engine	Torque (#1, #2)
	NR
	NP (#1, #2)
	NG (#1, #2)
	Egt (#1, #2)
	Oil Temperature (#1, #2)
	Oil PSI (#1, #2)
	Oil Quantity (#1, #2)
XMSN	Pressure (Fwd, Aft, Mix, Left, Right)
	Temperature (Fwd, Aft, Mix, Left, Right)
Hyraulics	Flt Ctrol PSI (#1, #2)
	Util Hyd PSI (#1, #2)
	Boost Servo PSI
Electrical	DC Gen Output (#1, #2)
	AC Rect Output (#1, #2)
APU	NP
	EGT
	011 PSI
	Accumulator PSI
	Gen Output Status

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TABLE 33. AG-1G RELATED SYSTEM PARAMETERS.

System	Parameters
Fuel	Time Remaining Lbs Remaining Pressure
Engine	Torque NR NP NG EGT Oil PSI Oil Temperature
XMSN	Pressure Temperature
Hydraulics	PSI (#1, #2)
Electrical	DC Gen Output AC Inv Output

TABLE 34. OH-58C RELATED SYSTEM PARAMETERS.

System	Parameters
Fuel	Time Remaining Lbs Remaining Pressure
Engine	Torque NR NP NG TOT Oil PSI Oil Temperature
xmsn	Pressure Temperature
Hydraulics	Pressure
Electrical	DC Gen Output AC Inv Output

TABLE 35. UH-60A PRIORITIZATION.

Priority	Message	Trigger	
1	Low Rotor RPM	NR <90%	
2	#1 Engine Out	NG <55%	
3	#2 Engine Out	NG <55%	
4	#1 Engine Fire		
5	#2 Engine Fire		
6	APU Fire		

	CAUTION MESSAGES	
Priority	Message	Trigger
7	Low Rotor RPM	NR <95%
8	Stabilator Inop	
9	#1 Overtorque	TRQ >114%
10	#2 Overtorque	TRQ >114%
11	Main Rotor overspeed	NR >125%
12	IFF Inoperative	
13	#1 NP High/Low	NP >110%, <90%
14	#2 NP High/Low	NP >110%, <90%
15	#1 Fuel Pressure Low	Press <8.5 PSI
16	#2 Fuel Pressure Low	Press <8.5 PSI
17	#1 NG High	NG >104%
18	#2 NG High	NG >104%
19	XMSN 01? Press Low/High	Press <25, >130 PSI
20	XMSN 011 Temp High	Temp >140°C
21	Chip Main XMSN	
22	Chip Intermediate XMSN	
23	Chip Tail XMSN	
24	#1 Engine Chip	
25	#2 Engine Chip	

TABLE 35. CONTINUED.

Priority	Message	Trigger
26	#1 Eng Oil Press Low/High	Press <25, >100 PSI
27	#2 Eng Oil Press Low/High	Press <25, >100 PSI
28	#1 Eng Oil Temp High	Temp >150°C
29	#2 Eng Oil Temp High	'Temp >150°C
30	#1 TGT High	TGT >850°C
31	#2 TGT High	TGT >850°C
32	#1 PRI Servo Press Low	Press <2000 PSI
33	#2 PRI Servo Press Low	Press <2000 PSI
34	#1 PRI Servo Jam	
35	#2 PRI Servo Jam	
36	Tail Rotor Servo Jam	
37	#1 HYD Pump Press Low	Press <2000 PSI
38	#2 HYD Pump Press Low	Press <2000 PSI
39	#1 Fuel Low	< 30 Mins
40	#2 Fuel Low	< 30 Mins
41	SAS Off	
42	Flt Path Stab Sys Inop	
43	DC Ess Bus Off	
44	AC Ess Bus Off	
45	Pitch Bias Failure	
46	#1 Gen Output Low	
47	#2 Gen Output Low	••
48	#1 Conv Output Low	
49	#2 Conv Output Low	
50	Boost Servo Jam	
51	#1 Oil Filter Bypass	
52	#2 Oil Filter Bypass	
53	XMSN 011 Bypass	
54	#1 Fuel Filter Bypass	••
55	#2 Fuel Filter Bypass	••
56	Battery Fault	
57	Battery Low Charge	••
58	APU Fail	
59	Gust Lock Not Disengaged	••
60	External Pwr Connected	

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TABLE 35. CONTINUED.

8 350		-
PKŁL	AUIIIM	MESSAGES

Priority	Message	Trigger
61	#1 Overtorque	TRQ >104%
62	#2 Overtorque	TRQ >104%
63	Main Rotor Overspeed	NR >103%
64	#1 NP High/Low	NP >103%, <95%
65	#2 NP High/Low	MP >103%, <95%
66	#1 NG High	NG >102%
67	#2 NG High	NG >102%
68	XMSN Oil Press Low/High	Press <35, >65 PSI
69	XMSN 011 Temp High	Temp >120°C
70	#1 Eng Oil Press Low/High	Press <45, >80 PSI
71	#2 Eng Oil Press Low/High	Press <45, >80 PS1
72	#1 Eng Oil Temp High	Tem; >135 ⁰ C
73	#2 Eng Oil Temp High	Temp >135°C
74	#1 TGT High	TGT >775°C
75	#2 TGT High	TGT >775°C
76	#1 Fuel Low	Settable
77	#2 Fuel Low	Settable
	ļ	1

Priority	Message	Trigger
78	Backup Pump On	
79	Cargo Hook Open	
80	Cargo Hook Armed	
81	Prime Boost Pump On	
82	APU On	
83	APU Gen On	
84	Pitot Heat On	
85	Engine Start Valve Open	
86	Parking Brake On	
87	#1 Eng Anti-Ice On	
88	#2 Eng Anti-Ice On	
89	Landing Light On	
90	Fuel Precaution Set At	Settable

TABLE 36. CH-47C PRIORITIZATION.

WARNING MESSAGES

Priority	Message	Trigger
1	Low Rotor RPM	NR <90%
2	#1 Engine Out	NG <55%
3	#2 Engine Out	NG <55%
4	#1 Engine Fire	-
5	#2 Engine Fire	-
6	APU Fire	-

CAUTION MESSAGES		
Priority	Hessage	Trigger
7	Low Rotor RPM	NR <95%
8	#I Overtorque	TRQ >114%
9	#2 Overtorque	TRQ >114%
10	Main Rotor Overspeed	NR >125%
11	IFF Inoperative	
12	#1 Main Fuel Press Low	Press <10 PSI
13	#2 Main Fuel Press Low	Press <10 PSI
14	#1 Fwd Aux Fuel Press Low	Press <10 PSI
15	#2 Fwd Aux Fuel Press Low	Press <10 PSI
16	#1 Aft Aux Fuel Press Low	Press <10 PSI
17	#2 Aft Aux Fuel Press Low	Press <10 PSI
18	#1 Xfeed Fuel Valve	
19	#2 Xfeed Fuel Valve	
20	#1 Engine Fuel Valve	
21	#2 Engine Fuel Valve	
22	#1 NG High	NG >104%
23	#2 NG High	NG >104%
24	Fwd XMSN 011 Press Low/High	Press <20, >90 PSI
25	Aft XMSN 011 Press Low/High	Press <20, >90 PSI

TABLE 36. CONTINUED.

CAUTION MESSAGES, cont.		
riority	Message	Trigger
26	Mix XMSN Oil Press Low/High	Press <20, >90 PSI
27	Left XMSN 011 Press Low/High	Press <20, >90 PSI
28	Right XMSN Oil Press Low/High	Press <20, >90 PSI
29	Fwd XMSN Oil Temp High	Temp >140°C
30	Aft XMSN Oil Temp High	Temp >140°C
31	Mix XMSN Oil Temp High	Temp >140°C
32	Left XMSN Oil Temp High	Temp >140 ⁰ C
33	Right XMSN 011 Temp High	Temp >140°C
34	XMSN Chip	
35	#1 Engine Chip	
36	#2 Engine Chip	
37	#1 Engine Oil Press Low/High	Press <40, >110 PSI
38	#2 Engine Oil Press Low/High	Press <40, >110 PSI
39	#1 Engine Oil Temp High	Temp >138 ⁰ C
40	#2 Engine Oil Temp High	Temp >138 ⁰ C
41	#1 Engine Oil Quantity Low	Qty <2 qts
42	#2 Engine Oil Quantity Low	Qty <2 qts
43	#1 EGT High	EGT >620°C
44	#2 EGT High	EGT >620°C
45	#1 HYD Pump Press Low	Press <2500 PSI
46	#2 HYD Pump Press Low	Press <2500 PSI
47	#1 Main Fuel Low	<30 Mins
48	#2 Main Fuel Low	<30 Mins
49	#1 Fwd Aux Fuel Low	<30 Mins
50	#2 Fwd Aux Fuel Low	<30 Mins
51	#1 Aft Aux Fuel Low	<30 Mins
52	#2 Aft Aux Fuel Low	<30 Mins
53	SAS OFF	••
54	#1 Gen Output Low	••
55	#2 Gen Output Low	
56	#1 Rect Output Low	
57	#2 Rect Output Low	
58	Boost Servo Press Low	
59	Utility Hyd. Press Low	

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TABLE 36. CONTINUED.

CAUTION MESSAGES, cont.

Priority	Message	Trigger
61	External Pwr Connected	••
62	Wheel De-Phased	
63	Heater Hot	

Priority	Message	Trigger
64	#1 Overtorque	TRQ >104%
65	#2 Overtorque	TRQ >104%
66	Main Rotor Overspeed	NR >103%
67	#1 NG High	NG >102%
68	#2 NG High	NG >102%
69	Fwd XMSN Qil Press Low/High	Press <30, >80 PSI
70	Aft XMSN Dil Press Low/High	Press <30, >80 PSI
71	Mix XMSN Oil Press Low/High	Press <30, >80 PSI
72	Left XMSN Oil Press Low/High	Press <30, >80 PSI
73	Right XMSN Oil Press Low/High	Press <30, >80 PSI
74	Fwd XMSN 0il Temp High	Temp >130°C
75	Aft XMSN Oil Temp High	Temp >130°C
76	Mix XMSN 011 Temp High	Temp >130°C
77	Left XMSN Oil Temp High	Temp >130°C
78	Right XMSN 0il Temp High	Temp >130°C
79	#1 Engine Oil Press Low/High	Press <50, >90 PSI
80	#2 Engine Oil Press Low/High	Press <50, >90 PSI
81	#1 Engine Oil Temp High	Temp >130°C
82	#2 Engine Oil Temp High	Temp >130°C
83	#1 EGT High	EGT >570 ⁰ C
84	#2 EGT High	EGT >570°C
85	#1 Main Fuel Low	Settable
86	#2 Main Fuel Low	Settable
87	#1 Fwd Aux Fuel Low	Settable
88	#2 Fwd Aux Fuel Low	Settable
89	#1 Aft Aux Fuel Low	Settable
90	#2 Aft Aux Fuel Low	Settable

TABLE 36. CONTINUED.

ADVISORY MESSAGES

Priority	Message	Trigger
91	#1 M7 CTRL Loop Energized	
92	#2 M1 CTRL Loop Energized	
93	Cargo Hook Open	
94	Parking Brake On	••
95	Fuel Precaution Set At	Settable

TABLE 37-AH-1G PRIORITIZATION.

WARNING MESSAGES

Priority	Message	Trigger	
1	Low Rotor RPM	NR <90%	
2	Engine Out	NG <55%	
3	Engine Fire	••	

CAUTION MESSAGES		
Priority	Message	Trigger
4	Low Rotor RPM	NR <95%
5	Overtorque	TRQ >114%
6	Main Rotor Overspeed	NR >125%
7	IFF Inoperative	
8	NP High/Low	NP >110%, <90%
9	Fuel Pressure Low	Press <5 PSI
10	NG High	NG >104%
11	XMSN Oil Press Low/High	Press <30, >70 PSI
12	XMSN 0il Temp High	Temp >110 ⁰ C
13	Chip Main XMSN	••
14	Chip Intermediate XMSN	••
15	Chip Tail XMSN	••
16	Engine Chip	
17	Engine Oil Press Low/High	Press <25, >110 PSI
18	Engine Oil Temp High	Temp >100°C
19	EGT High	EGT >625°C
20	#1 HYD Press Low	••
21	#2 HYD Press Low	••
22	Fuel Low	< 30 Mins
23	DC Gen Output Low	••
24	AC Inv Output Low	
25	Oil Filter Bypass	••

TABLE 37. CONTINUED.

Priority	Message	Trigger
26	XMSN 011 Bypass	
27	Fuel Filter Bypass	
28	Fwd Fuel Boost Press Low	
29	Aft Fuel Boost Press Low	
30	External Pwr Connected	

PRECAUTION NESSAGES

Priority	Message	Trigger
31	Overtorque	TRQ > 104%
32	Main Rotor Overspeed	NR > 103%
33	NP High/Low	NP> 103%, < 95%
34	NG High	NG > 102%
35	XMSN 0il Press Low/High	Press <40, >60 PSI
36	XMSN 0il Temp High	Temp> 105°C
37	Engine Oil Press Low/High	Press <80, >100 PSI
38	Engine 011 Temp High	Temp > 93°C
39	EGT High	EGT>610°C
40	Fuel Low	Settable

ADVISORY MESSAGES

Priority	Message	Trigger			
41	Fuel Precaution Set At	Settable			

TABLE 38. OH-58C PRIORITIZATION.

Priority	Message	Trigger
1	Low Rotor RPM	NR <90%
2	Engine Out	NG <55%
3	Engine Fire	

CAUTION MESSAGES					
Priority	Message	Trigger			
4	Low Rotor RPM	NR <95%			
5	Overtorque	TRQ >114%			
6	Rotor Overspeed	NR >110%			
7	1FF Inoperative	}			
8	NP Low/High	NP <95%, >105%			
9	Fuel Pressure Low	ТВО			
10	NG High	NG >105%			
11	XMSN 011 Press Low/High	Press <30, >70 PSI			
12	XMSN 0il Temperature High	Temp >110°C			
13	Chip Main XMSN	••			
14	Chip Intermediate XMSN	l			
15	Chip Tail XMSN				
16	Engine Chip				
17	Engine Oil Press Low/High	Press <50, >130 PSI			
18	Engine Oil Temperature High	Temp >107°C			
19	TOT High	TOT >810°C			
20	Hydraulic Pressure Low	j			
21	Fuel Low	< 30 Mins			
22	DC Generator Output Low				
23	AC Inverter Output Low				
24	Oil Filter Bypass				
25	Fuel Filter Bypass				
26	Fuel Boost Pressure Low				

TABLE 38. CONTINUED.

PRECAUTION MESSAGES

Priority	Message	Trigger
17	Overtorque	TRQ >104%
28	Rotor Overspeed	NR >103%
29	NP Low/High	NP <98%, >102%
30	NG High	NG >102%
31	XMSN 0il Pressure Low/High	Press <40, >60 PSI
32	XMSN Temperature High	Temp >105 ⁰ C
33	Engine Oil Pressure Low/High	Press <110, >120 PSI
34	Engine Oil Temperature High	Temp >100°C
35	TOT High	TOT >738°C
36	Fuel Low	Settable

ADVISORY MESSAGES

Priority	Message	Trigger
37	Fuel Precaution Set At	Settable

TABLE 39. RELATED PARAMETER GROUPS.

Group Parameters Engine Torque (Q) No. 1 & No. 2 Rotor Speed (Ng) Power Turbine Speed (Np) No. 1 & No. 2 Gas Generator Speed (Ng) No. 1 & No. 2 Gas Turbine Temperature (TGT) No. 1 & No. 2 Engine 011 Pressure (Po) No. 1 & No. 2 Engine 011 Temperature (To) No. 1 & No. 2 Engine Fire No. 1 & No. 2 Engine Chip No. 1 & No. 2 Oli Filter Bypass No. 1 & No. 2

- Fuel Pressure No. 1 & No. 2
 Fuel Low No. 1 & No. 2
 Total Fuel
 Fuel Filter Bypass No. 1 & No. 2
- Transmission 011 Pressure
 Transmission 011 Temperature
 Transmission 011 Bypass
 Chip, Main Transmission
 Chip, Intermediate Transmission
 Chip, Tail Transmission
- 4 Hydraulic Pump Pressure No. 1 & No. 2
 Primary Servo Pressure No. 1 & No. 2
 Tail Rotor Servo Pressure
 Boost Servo Pressure
 Pitch Bias Failure

TABLE 39. CONTINUED.

Group	<u>Parameters</u>
\$	Generator Output No. 1 & No. 2
	Convertor Output No. 1 & No. 2
	DC Essential Bus ON/OFF
	AC Essential Bus ON/OFF
	Sattery Fault
	Battery Low Charge
6	APU Power Turbine Speed
	APU Gas Temperature
	APU 011 Pressure
	Accumulator Pressure
	APU Generator Output
	APU Fail
	APU Fire
7	Stabilator Auto Mode Inoperative
	Flight Path Stabilization System Inoperative
	SAS OFF
8	IFF Inoperative

TABLE 40. PROPERTIES OF DATA TRANSMISSION CABLES.

	Fiber Optics	Coax	Twisted Pair
Low Cost	x		x
Temperature to 300°C	x	X	X
Vibration Tolerant	x	x	x
Low Cross Talk	x	X	
No Cross Talk	x		
EMI Noise Immunity	x		
Total Electrical Isolation	x		
No Spark/Fire Hazards	x		
No Short-Circuit Loading	x		
No Ringing/Echoes	x		
EMP Immunity	x		
Temperature to 1000°C	x		
Weight Savings	x		
Decreased Stze	x		
Bandwidth Capability			
(300 meters)	200 MHz	20 MHz	1 Miz

TABLE 41. SSM WORKLOAD REDUCTION FEATURES.

	VISUAL SEARCH REDUCED	VIGILANCE ENHANCED	IDENTIFICATION ENHANCED	CLASSIFICATION ENHANCED	IRRELEVANT FEATURES REDUCED	MEMORY LOAD REDUCED	COMPUTATION REDUCED	ATTENSITY ENHANCED	DECISION-MAKING REDUCED	RESPONSE SELECTION ENHANCED	
CWP DISPLAY	×	x	x	x	x	x			x	x	
PRECAUTION INDICATION	x	X		X	x	x			x	x	
DISPLAY BY EXCEPTION	x	X		X	x	x			x	x	
POWER MANAGEMENT DISPLAY	x	x	x		x	x				x	
PRIORITIZATION			x	x		x			x	x	
DISPLAY FORMATS			X	X	x			x			
PERIPHERAL FUNCTIONS						x	x		x	x	

TABLE 42. SSM DELTA ESTIMATES: AIRCRAFT WEIGHT

AIRCRAFT

	S0A	NT	LT
UH60-A	+ 60	+ 15	+ 15
CH47-C	+ 30	-25	-30
AH1-G	+ 100	+ 60	+ 60
0H58-C	+ 105	+ 60	+ 60

SOA: state-of-the-art (current) design; NT: near-term design; LT: long-term design. Consult text for qualification of these estimates (Task IV).

TABLE 43. UH-60A LIFE CYCLE COST ESTIMATES.

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VER	SION	FLEET LCC DELTA	PER AIRCRAFT LCC DELTA
NT	(5 YRS)	\$12,000,000	\$11,000
LT	(10 YRS)	\$22,000,000	\$25,000
		(1979 CONSTANT DOLL	.ARS)

Consult text for qualification of these estimates.

APPENDIX B: PILOT QUESTIONNAIRE.

SUBSYSTEM STATUS MONITOR

NAME:	
ORGANIZATION:	
PHONE:	
TOTAL HELICOPTER HOU	RS:
Hours UH-1	
Hours OH-58	
Hours AH-1	
Hours CH-47	
Hours UH-60A	
NOE HOURS:	
NIGHT HOURS:	
CURRENT HELICOPTER A	SSIGNMENT:

Explanations and Directions

The purpose of this questionnaire is to survey the opinions of experienced helicopter pilots in order to determine ways of reducing crew workload during NOE Flight. The questionnaire is limited to methods of displaying and responding to subsystem status monitoring information. You are asked to consider carefully a variety of items of subsystem information, and to decide whether the information is necessary, and when and how it should be displayed so that the crew's workload may be reduced. Your careful decisions will influence the design of future subsystem monitors in helicopters.

I. Priorities

Explanation

In this section you are asked to decide whether it is necessary for you to be informed of the status of various subsystems, and to explain what makes this information necessary.

Directions

- Mark an X in the column labeled:
- Safety If you decide that it is difficult or impossible to maintain the safety of the helicopter and its crew without this information
- <u>Mission</u> If you decide that it is difficult or impossible to complete a mission without this information (even though the information is not necessary for maintaining the safety of the aircraft and crew).
- Maintenance If you decide that the information is necessary to assist you in recommending maintenance items (even though the information is not necessary to maintain safety or to complete a mission)
- Unnecessary If you decide that the information is not necessary in order to maintain safety, complete a mission, or recommend maintenance.
- * Only one (1) column should be marked for each item of information considered in this section.
- ** If you mark the $\frac{\text{UNNECESSARY}}{\text{other sections}}$ for an item, there is no need to continue to the $\frac{\text{other sections}}{\text{other sections}}$ for that item.

II. Mission Phase

Explanation

In this section you are asked to explain when during a typical mission it is necessary for you to be informed of the status of various subsystems, and when during a typical mission the information is unnecessary.

- Lau .

<u>Directions</u>

Mark an X in the column labeled:

<u>TAKEOFF</u> - if you decide the information is necessary before, during, or immediately after takeoff.

CRUISE - if you decide the information is necessary during cruise

HOVER - if you decide the information is necessary during hover

LAND - if you decide the information is necessary during landings.

III. Environment

Explanation

In this section you are asked to explain the environmental conditions during which it is necessary for you to be informed of the status of various subsystems, and the environmental conditions during which the information is unnecessary.

Directions

Mark an \underline{X} in the column labeled:

NIGHT - if you decide the information is necessary during night flight

DAY - if you decide the information is necessary during daytime flight

VMC - if you decide the information is necessary during VMC flight

IMC - if you decide the information is necessary during the IMC flight

NOE - if you decide the information is necessary during the NOE flight

ALTITUDE- if you decide the information is necessary during flight at ALTITUDE

* More than one column may be marked for each item of information considered in this section.



^{*} More than one column may be marked for each item of information considered in this section.

IV. Display

Explanation

In this section you are asked to decide whether it is necessary to display items of information at all times, or whether other means of display are more appropriate.

Directions

Mark an X in the column labeled:

<u>CONTINUAL</u> - if you decide that the information must be displayed at all times

CRITICAL ONLY

- if you decide that the information must be displayed only to announce a critical condition affecting aircraft safety or mission completion

ACCESS ONLY

- if you decide that the information must be displayed only through call-out by pilot or copilot

* Only one (1) column should be marked for each item of information considered in this section.

V. Format

Explanation

In this section you are asked to decide upon the least amount of content required to display the necessary information for the various subsystems.

Directions

Mark an X in the column labeled:

<u>QUANTITATIVE</u> - if you decide that numerical (scale or digital) information must be displayed

QUALITATIVE - if you decide that numerical information is not necessary, but that both "within limits" and "beyond limits" indication is necessary.

<u>COMBINED</u> - if you decide that it is necessary to display both numerical and within/beyond limits information simultaneously

<u>CAUTION</u> - if you decide that is is necessary only to display "beyond limits" information.

ADVISORY - if you decide that it is necessary only to be advised that the system is engaged or in operation.

* Only one (1) column should be marked for each item of information in this section.



VI. Response

Explanation

In this section you are asked to decide whether it would be desirable to incorporate an automated response to the information displayed, or whether the crew must respond to the condition displayed.

<u>Directions</u>

Mark an \underline{X} in the column labeled:

- if you decide that it would be desirable to automate the response to the information displayed
- AUTO NOT DESIRABLE if you decide that it would not be desirable to automate the response to the information displayed, and that the crew must respond to the condition.
- * Only one (1) column should be marked for each item of information considered in this section.
- ** If you mark <u>AUTO NOT DESIRABLE</u> for an item, there is no need to proceed to the next <u>Section</u> for that item.

VII. Feedback

Explanation

In this section you are asked to consider those items which you have marked <u>AUTO DESIRABLE</u>, and to decide whether it is necessary to inform the crew that such an automated response has been made.

Directions

Mark an \underline{X} in the column labeled:

<u>Display</u> - if you decide that it is necessary to inform the crew that the automated response has been made

<u>Display Unnecessary</u> - if you decide that it is not necessary to inform the crew that the automated response has been made

* Only one (1) column should be marked for each item of information considered in this section.

VIII. Remarks

In this section you are asked to include any remarks, comments, suggestions, or problems that occur to you in considering each subsystem.

Especially useful would be remarks such as: "This information is unnecessary so long as (some other information) is provided."



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fuel Boast Pressure Low				_			
Engine Oil Temperature				_			
Englae Oil Temperature High							
Engine Oil Pressure							
Engine Oil Pressure Low							
Engine Oil Quantity							
Engine Oil Quantity Law							
Off filter Bypass							
Engine Chip							



PARMETER	PRIORITIES		MISSION PHASE	ENVIRONMENT	Sig	DISPLAY	FORMAT	AE. PONSE		FFED- BACK	REMARKS
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Chip Main 2015H											
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INSA OII Bypass											
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PARAMETER	PRIORITIES	MISSION PHASE	ENVIRONMENT	DISPLAY	FORMAT	PONSE.	FEEB- GACK	REMARKS
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APU Oil Pressure Low								
APV Overspeed								
APU Underspeed								
APU Sequence Fall								
APU Fire		111111		111				
APV Generator Ch								
APU Ch				-				
. APU Tachameter								
Generator Output								
AC Invertor Detput ton								
Converter Dutput tow								
Actifier Off					$\Pi\Pi$			
Bettery Law Charge								
Dettery fault								
AC ESS Bus Off								
BC Ess Bus Off								
External Power Connected	=						\exists	

PARAMETER	PRICEITIES	MISSION PHASE	ENV I ROIPIER?	DISPLAY	FORMT	ME- PONSE	FEED- BACK REMARKS
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AC Lood Meter							
IC Load Mater							
Engine Fire							
Fit Path Stab Sys Fall							
Stabilator Auto Made in Op							
Stabilator Position							
SAS Off							
Pitch Bias Failure							
Gust Lock Not Disengaged							
If In-Operative							

REMARKS																				
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-24.

Additional Areas

Please answer the following questions:

Can you think of any other items of subsystem information that should be displayed in future helicopters?

Which caution/warning lights have you found illuminate most frequently? How frequently? During what conditions?

Are there any caution/warming lights that you have found to be unreliable?

What aspects of subsystem monitoring have you found to be most problematic, annoying, or distracting during NOE flight?

How do you feel about presenting information through voice warning systems or through beeps, tones, etc.?

What problems do you see arising with systems that require you to push buttons to obtain information about subsystems?

APPENDIX C: CONTROL ALLOCATION CONCEPTS

"Control allocation" is a term referring to the decision-making program by which a computer monitors system operation, decides when corrective response is required, and decides whether to perform the corrective response automatically or to inform the human operator of the condition, allowing him to perform the response.

The emphasis in control allocation is upon software programming combining an open loop option (assigning control to the pilot) with closed loop features (automatic response by the machine) into a single monitoring controller, as opposed to systems which isolate machine from human control, or assign control allocation decisions to the human operator.

The application of on-board computer systems including remote sensing terminals and central processing units allows for both preprogramming of allocation of control and alteration of such programs. This software capability has raised intriguing and currently largely theoretical possibilities for adaptive computer-aided control. In adaptive computer-aided control, programming of control allocation is flexible and may be adapted for and by individual crew members, either by accepting of control allocation logic programmed by any given pilot (which may differ from another pilot's program), or by monitoring a pilot's responses over time and developing a model of control allocation that will duplicate the pilot's preferences for specified decisions.

An example of pilot preprogramming included in the SSM is the selection of the level at which a FUEL LOW precaution will be displayed. Each pilot may select or program a different level. The example is quite elementary, but the inclusion of an automated response as a program element would constitute an example of more extensive adaptive computeraided control.

A program that would average pilot preferences for fuel precaution level over time rather than rely upon the last set level, as in the proposed SSM design, and respond to the average in the absence of any resetting after engine shutdown/startup would represent an example of the modelling feature of adaptive computer-aided control.

Looking toward a future in which each crew member programs the aircraft to his specific requirements, advocates of adaptive computer-aided control point to the following potential benefits:

- 1. Unburdening: relieves the operator of continuous monitoring and decision-making, freeing him for other command and control functions.
- 2. Consistency: replacing continual operator control by a decision model may significantly increase decision-making consistency, and can help insure that decisions are made optimally with respect to normative criteria.
- 3. Performance: may improve on secondary tasks because of unburdening. The potential for flexible, adaptive computer-aided control leads to a variety of unanswered questions:
- 1. Will the concept ever achieve acceptance? Laboratory studies have shown that operators are quite willing to receive assistance from an aiding device which incorporates their own preferences, especially

once the guiding principles have been explained.

2. What forms and extent of information feedback are appropriate for operator cognizance of system operation?

3. What levels of systems are appropriate for programming? Should monitoring, display, or response be programmable, or all three?

4. How should programmable systems be protected from programming error?

5. How should programmable systems protect one human user from another?

While some form of control allocation will be an aspect of most computerized monitoring and control systems that involve human operators, the provisions for adaptive computer-aided control will require detailed study in the future. The utility of the concept of computer-aided adaptive control has not been extensively applied and proven in aircraft command and control. Both the concept and its applications require further study.

